APPENDIX G

Civil Design

Civil Design Appendix

South San Francisco Bay Shoreline Study

U.S. Army Corps of Engineers, San Francisco District

December 2014

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1.0 General

1.1 Purpose

This civil design report is a technical appendix to the South San Francisco Bay Shoreline Study (Shoreline Study). The purpose of this Civil Design Appendix is to provide additional information regarding the technical aspects of engineering elements. These technical details presented pertain to the construction of the new or improved levees that protect the community of Alviso, CA as authorized by the Committee on Transportation and Infrastructure of the U.S. House of Representatives on July 24, 2002 (Docket 2697). The purpose of this study is to determine the feasibility and the Federal interest of a combined tidal Flood Risk Management (FRM) and Ecosystem Restoration (ER) project.

1.2 Authority

The Shoreline Study is being prepared in response to the resolution adopted by the Committee on Transportation and Infrastructure of the U.S. House of Representatives on July 24, 2002, for the South San Francisco Bay Shoreline Study (Shoreline Study), California (Docket 2697), which reads as follows:

> *"Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the Final Letter Report for the San Francisco Bay Shoreline Study, California, dated July 1992, and all related interims and other pertinent reports to determine whether modifications to the recommendations contained therein are advisable at the present time in the interest of tidal and fluvial flood damage reduction, environmental restoration and protection and related purposes along the South San Francisco Bay shoreline for the counties of San Mateo, Santa Clara and Alameda, California."*

1.3 Background

The Shoreline Study was originally authorized by Congress in 1976 to assess the need for flood risk management in the San Francisco South Bay (South Bay). A subsequent flood control study, issued in 1992 by the U.S Army Corps of Engineers (Corps), found that a Federal flood management project along the South Bay shoreline was not economically justifiable mainly because it was determined that Cargill Salt would continue to maintain their existing salt pond levees due to their economic interest in keeping ocean and river water from diluting the brines of its salt-making operations. These salt pond levees were not engineering levees; however, they provided incidental flood risk management for the surrounding communities.

In 2003, the Federal and state governments began planning a restoration project when they acquired 15,100 acres of salt ponds from Cargill Salt in the South Bay. The planned restoration project would affect the utility of the salt pond levees as flood protection structures. As a result, the U.S. House of Representatives requested that the Corps review its previous study on flood management along the South Bay shoreline as well as to include environmental restoration and protection, and tidal and fluvial flood risk management.

The Corps completed an initial reconnaissance analysis in September 2004, which determined that due to the current and future anticipated conditions in the South Bay, it was likely that a Federal flood risk management and ecosystem restoration project would be justified. On October 24, 2005, the Corps, the U.S. Fish and Wildlife Service (FWS), the Santa Clara Valley Water District (SCVWD) and the California State Coastal Conservancy (Conservancy) kicked off the first study phase of the Shoreline Study. This first phase covers the southern portion of the South Bay, including the Alviso Ponds and other lands and waters stretching from southwest Fremont to Palo Alto.

1.4 Study Area and Existing Conditions

The Shoreline Study (**Figure 1 - Study Area**) encompasses shoreline and floodplain areas, three groups of former salt production ponds, and other parcels that represent additional opportunities for flood risk management and/or ecosystem restoration benefits along the South Bay in Northern California. The Shoreline Study area extends from the Ravenswood Ponds in San Mateo and State Route (SR) 92 in the city of Hayward south along both sides of the bay to its southern end, and includes adjacent areas that may be flooded by the bay and/or that may offer opportunities for restoration of tidal and related habitats.

The study area for this phase of the project is located near the town of Alviso in San Jose, CA and adjacent to the San Jose – Santa Clara Water Pollution Control Plant (WPCP). There are three significant streams in the area, Alviso Slough, which is to the West of Alviso; Coyote Bypass, which is north of the water treatment plant; and Artesian Slough, which flows out of the water treatment plant. Alviso is surrounded by the New Chicago Marsh, and Ponds A12, A13 and A16. Pond A18 is to the northwest of the water treatment plant.

The foundation soils in the study area consist primarily of Bay Mud. Bay Mud is normally consolidated and typically very weak clayey/silty soil. The Bay Mud is approximately 5 to 40 feet thick in the project area and contains occasional inclusions of organics in the upper 10 feet of the soil profile.

Near Artesian Slough is the Don Edwards Education Center which must be taken into consideration during the analysis. Also on the project site is the Union Pacific Rail Road running in a North-South direction on the west side of Alviso, and the Zanker Landfill to the southern portion of Artesian Slough.

2.0 Alternative Selection and Project Development

2.1 Flood Risk Management Options

Several Flood Risk Management (FRM) options were formulated to provide an array of flood management options at differing levels of protection (LOP) across several potential alignments.

The purpose of this array was to provide a wide range of options that would allow for estimating quantities, costs, and benefits at each alignment at each LOP. This array was used to evaluate and compare options to determine the National Economic Development (NED) Plan and the Locally Preferred Plan (LPP). Each of these FRM options involves the construction of new, engineered levees.

2.1.1 Levee Design Considerations

Where levees will be constructed in place of existing salt pond dikes, the existing dikes and an inspection trench will be excavated before new fill is placed. Based on geotechnical requirements (Appendix O), the built to elevation will be the design top of fill plus an allowance for foundation settlement. In areas where the height of fill exceeds the allowable placement, wick drains will be installed prior to levee fill placement. Geotechnical data also indicates the existing dikes are underlain with bay mud ranging from 0 to 25 feet deep.

The new and reconstructed levees have been designed with a 3:1 grade on both the waterside and landside slope. Based on geotechnical requirements (Appendix O), the new and reconstructed levee crowns will be 16 feet wide. The crown will slope 2% from the centerline. There will be a 12-foot wide access road along the top of the levee to accommodate non-Federal sponsor requirements for inspection. A 12-foot wide access road provides an 8-foot width trafficable surface for operations and maintenance traffic, and includes 2-foot wide shoulders. The top of levee design elevation is set to the crown hinge point. In areas where the new levee coincides with roadways, the levee crown width will be increased to conform existing grades and turns. Additionally, levee surfacing will match the existing surface as necessary.

2.1.2 Alignments

For the purpose of developing alignments for the project, the project was split into an Alviso side, and a San Jose / Santa Clara Water Pollution Control Plant (WPCP) side, separated by Artesian Slough in the middle. A series of levee alignments were devised for either side, each of which provided different benefits and drawbacks. A total of 3 alignments were developed for the Alviso side and 2 alignments were developed for the WPCP side.

2.1.2.1 Alviso Alignments

Three alignments were developed for the Alviso side of the project. They are as listed below:

- Alviso North: This alignment involves the removal and reconstruction of levees from existing high ground to the west of Alviso along the existing dikes bordering ponds A12, 13, and 16. This alignment ties into the closure structure at Artesian Slough just north of the Don Edwards Center. The total length of this alignment is approximately 9,600 feet.
- Alviso Railroad: This involves the removal and construction of levees from existing high ground to the west of Alviso along the existing dikes bordering pond A12 and then

east along the existing Union Pacific Rail Road (UPRR) line to Grand Blvd. The alignment follows Grand Blvd to the Artesian Slough dikes and continues to just north of the Don Edwards Center to tie into the closure structure at Artesian Slough. The total length of this alignment is approximately 12,600 feet.

- Alviso South: This alignment involves the removal and construction new levees from existing high ground West of Alviso south through the town of Alviso. The alignment follows the outer boundary of Alviso, then follows Grand Blvd to the East and ties into a proposed closure structure just north of the Don Edwards Center. Portions of Grand Blvd will be raised and widened to accommodate levee construction. The total length of this alignment is approximately 14,200 feet.

2.1.2.2 WPCP Alignments

Two alignments were developed for the WPCP side of the project. They are as listed below:

- WPCP North: This alignment involves the construction of new levees from the closure on the west side of Artesian Slough through Pond A18 similar to that found in the San Jose – Santa Clara WPCP Master Plan. The levees will tie into the existing levees along Coyote Creek to the north side of the project. The total length of this alignment is approximately 10,200 feet.
- WPCP South: This alignment involves the removal and construction of new levees from the closure on the west side of Artesian Slough along the southern border of Pond A18 along the existing dikes adjacent to the WPCP. The levees will tie into the existing levees along Coyote Creek to the north side of the project. The total length of this alignment is approximately 10,100 feet.

2.1.3 Artesian Slough Closures

Two options were developed for providing tidal flood risk management around Artesian Slough. These are described below:

- Levees: The first option for tidal flood risk management consists of constructing levees from just north of the Don Edwards Center to tie into existing high ground at the nearby landfill. The levees would then be constructed from the south portion of Artesian Slough north to tie into the WPCP alignment.
- Tide gate: The other option for tidal flood risk management consists of constructing a tide gate across Artesian Slough connecting the levees on the Alviso and WPCP alignments.

2.1.4 Levels of Protection

Four different LOPs were analyzed for potential flood risk management. The 25-, 50-, 100-, and 200-year LOPs were considered, which correlate to the 4%, 2%, 1%, and 0.5% Annual Chance of Exceedence (ACE) respectively. Design top of levee elevations were based on hydraulic model results performed to estimate water surface elevations.

2.1.5 FRM Final Array

An initial array of options made from combinations of the alignments, LOPs, and Artesian Slough closures was made that provides a comparison between the different combinations of the three. Quantities, estimates and benefits were developed for the seven initial options. These seven initial options were used to extrapolate estimates for four new options that were used for the analysis of determining the LPP and the NED Plan. The four new options were developed based on analyses of the initial seven options, along with non-Federal sponsor input, and together with the initial seven options formed the final array of 11 FRM options. A detailed description and figures showing the final array of FRM options is shown in Chapter 3.

Table 1. Summary of Final Array of FRM Options

Option	Level of Protection (-year)	Alviso Alignment	WPCP Alignment	Alviso Slough Closure	Approximate Total Length At Analysis (ft.)	Estimated Cost ($)
1A	200	North	North	Tide Gate	19,855	70,364,798
1B	100	North	North	Tide Gate	19,855	70,357,212
1C	50	North	North	Levees	24,606	81,566,366
1D	25	North	North	Tide Gate	19,855	65,403,971
2 (LPP)	100	North	South	Tide Gate	19,929	73,459,432
3	200	RR	North	Tide Gate	22,786	74,269,014
4	50	South	South	Tide Gate	24,675	82,894,824
5	100	RR	South	Tide Gate	22,400	78,284,646
6	100	South	South	Tide Gate	24,675	86,150,430
7 (NED)	25	North	South	Tide Gate	19,929	68,287,791
8	200	North	South	Tide Gate	19,929	73,467,353

2.1.6 FRM Option 1A – Alviso North and WPCP North, 200-year event

Option 1A (**Figure 2 – FRM Option 1A**) involves the removal and reconstruction of levees from existing high ground West of Alviso along the existing dikes bordering ponds A12, 13, and 16. The levees will tie into a new tide gate north of the Don Edwards Center at Artesian Slough.

New levees will be constructed from the tide gate through pond A18, tying into the Coyote Creek Bypass northeast of the WPCP sludge ponds. These levees will follow the alignment defined in the WPCP Master Plan. The levees, tide gate, and closure structure at the UPRR will be construction to an elevation of 16.27 feet, plus allowances for settlement.

Due to the concerns regarding the structural integrity of the existing dikes, this option involves the replacement of the entire dike alignment. Additional geotechnical studies will be required to identify reach segments to determine how much existing dike material is suitable for re-use.

The new levee would have a crown width of 16 feet for the entire length as well as 3:1 side slopes and would provide a 200-year level of protection. Project geotechnical data indicates the existing dikes are underlain with Bay Mud, a highly compressible soil; therefore, a nominal foundation excavation plan is assumed. Also, to accommodate construction on deep bay mud in one phase rather than 2 or 3 over the course of several years, approximately 2,600,364 linear feet of wick drains will be necessary.

2.1.7 FRM Option 1B – Alviso North and WPCP North, 100-year event

Option 1B (**Figure 3 – FRM Option 1B**) involves the removal and reconstruction of levees from existing high ground West of Alviso along the existing dikes bordering ponds A12, 13, and 16. The levees will tie into a new tide gate north of the Don Edwards Center at Artesian Slough.

New levees will be constructed from the tide gate through pond A18, tying into the Coyote Creek Bypass northeast of the WCPC sludge ponds. These levees will follow the alignment defined in the WPCP Master Plan. The levees, tide gate, and closure structure at the UPRR will be construction to an elevation of 15.85 feet, plus allowances for settlement.

Due to the concerns regarding the structural integrity of the existing dikes, this option involves the replacement of the entire dike alignment. Additional geotechnical studies will be required to identify reach segments to determine how much existing dike material is suitable for re-use.

The new levee would have a crown width of 16 feet for the entire length as well as 3:1 side slopes and would provide a 100-year level of protection. Project geotechnical data indicates the existing dikes are underlain with Bay Mud, a highly compressible soil; therefore, a nominal foundation excavation plan is assumed. Also, to accommodate construction on deep Bay Mud in one phase rather than 2 or 3 over the course of several years, approximately 2,618,822 linear feet of wick drains will be necessary.

2.1.8 FRM Option 1C – Alviso North and WPCP North with no Tide Gate, 50-year event

Option 1C (**Figure 4 – FRM Option 1C**) involves the removal and reconstruction of levees from existing high ground West of Alviso along the existing dikes bordering ponds A12, 13, and 16. The levees will continue upstream on both banks of Artesian Slough to daylight at design grade.

New levees will be constructed from levee on Artesian Slough through pond A18, tying into the Coyote Creek Bypass northeast of the WCPC sludge ponds. These levees will follow the alignment defined in the WPCP Master Plan. The levees and closure structure at the UPRR will be construction to an elevation of 15.41 feet, plus allowances for settlement.

Due to the concerns regarding the structural integrity of the existing dikes, this option involves the replacement of the entire dike alignment. Additional geotechnical studies will be required to identify reach segments to determine how much existing dike material is suitable for re-use.

The new levee would have a crown width of 16' for the entire length as well as 3:1 side slopes and would provide a 50-year level of protection. Project geotechnical data indicates the existing dikes are underlain with Bay Mud, a highly compressible soil; therefore, a nominal foundation excavation plan is assumed. Also, to accommodate construction on deep Bay Mud in one phase rather than 2 or 3 over the course of several years, approximately 2,791,029 linear feet of wick drains will be necessary.

2.1.9 FRM Option 1D – Alviso North and WPCP North, 25-year event

Option 1D (**Figure 5 – FRM Option 1D**) involves the removal and reconstruction of levees from existing high ground West of Alviso along the existing dikes bordering ponds A12, 13, and 16. The levees will tie into a new tide gate north of the Don Edwards Center at Artesian Slough.

New levees will be constructed from the tide gate through pond A18, tying into the Coyote Creek Bypass northeast of the WPCP sludge ponds. These levees will follow the alignment defined in the WPCP Master Plan. The levees, tide gate, and closure structure at the UPRR will be construction to an elevation of 14.96 feet, plus allowances for settlement.

Due to the concerns regarding the structural integrity of the existing dikes, this option involves the replacement of the entire dike alignment. Additional geotechnical studies will be required to identify reach segments to determine how much existing dike material is suitable for re-use.

The new levee would have a crown width of 16 feet for the entire length as well as 3:1 side slopes and would provide a 25-year level of protection. Project geotechnical data indicates the existing dikes are underlain with Bay Mud, a highly compressible soil; therefore, a nominal foundation excavation plan is assumed. Also, to accommodate construction on deep Bay Mud in one phase rather than 2 or 3 over the course of several years, approximately 2,531,963 linear feet of wick drains will be necessary.

2.1.10 FRM Option 2 – Alviso North and WPCP South, 100 year event

Option 2 (**Figure 6 – FRM Option 2)** involves the removal and reconstruction of levees from existing high ground West of Alviso along the existing dikes bordering ponds A12, 13, and 16. The levees will tie into a new tide gate north of the Don Edwards Center at Artesian Slough.

New levees will be constructed from the tide gate along the existing pond A18 alignment, tying into the Coyote Creek Bypass northeast of the WPCP sludge ponds. The levees, tide gate, and closure structure at the UPRR will be construction to an elevation of 15.85 feet, plus allowances for settlement.

Due to the concerns regarding the structural integrity of the existing dikes, this option involves the replacement of the entire dike alignment. Additional geotechnical studies will be required to identify reach segments to determine how much existing dike material is suitable for re-use.

The new levee would have a crown width of 16 feet for the entire length as well as 3:1 side slopes and would provide a 100-year level of protection. Project geotechnical data indicates the existing dikes are underlain with Bay Mud, a highly compressible soil; therefore, a nominal foundation excavation plan is assumed. Also, to accommodate construction on deep Bay Mud in one phase rather than 2 or 3 over the course of several years, approximately 2,661,126 linear feet of wick drains will be necessary.

2.1.11 FRM Option 3 – Alviso RR and WPCP North, 200-year event

Option 3 (**Figure 7 – FRM Option 3)** involves the construction of new levees from existing high ground West of Alviso along the existing dikes bordering pond A12, and east along the existing UPRR line to Grand Blvd. The levees will follow Grand Blvd to the Artesian Slough levees and go north around the outside of the Don Edwards Center and there tie into a new tide gate.

New levees will be constructed from the tide gate through pond A18, tying into the Coyote Creek Bypass northeast of the WPCP sludge ponds. These levees will follow the alignment defined in the WPCP Master Plan. The levees, tide gate, and closure structure at the UPRR will be construction to an elevation of 16.27 feet, plus allowances for settlement.

Due to the concerns regarding the structural integrity of the existing dikes, this option involves the replacement of the entire dike alignment. Additional geotechnical studies will be required to identify reach segments to determine how much existing dike material is suitable for re-use.

The new levee would have a crown width of 16 feet for the entire length as well as 3:1 side slopes and would provide a 200-year level of protection. Project geotechnical data indicates the existing dikes are underlain with Bay Mud, a highly compressible soil; therefore, a nominal foundation excavation plan is assumed. Also, to accommodate construction on deep Bay Mud in one phase rather than 2 or 3 over the course of several years, approximately 2,185,656 linear feet of wick drains will be necessary.

2.1.12 FRM Option 4 – Alviso South and WPCP South, 50-year event

Option 4 (**Figure 8 – FRM Option 4)** involves the construction of levees from existing high ground West of Alviso south to the town of Alviso. The new levee alignment will follow the outer boundary of Alviso, go along Grand Blvd to the East and tie into a new tide gate north of the don Edwards Center at Artesian Slough.

New levees will be constructed from the tide gate along the existing pond A18 alignment, tying into the Coyote Creek Bypass northeast of the WPCP sludge ponds. The levees, tide gate, and closure structure at the UPRR will be construction to an elevation of 15.41 feet, plus allowances for settlement.

Due to the concerns regarding the structural integrity of the existing dikes, this option involves the replacement of the entire dike alignment. Additional geotechnical studies will be required to identify reach segments to determine how much existing dike material is suitable for re-use.

The new levee would have a crown width of 16 feet for the entire length as well as 3:1 side slopes and would provide a 50-year level of protection. Project geotechnical data indicates the existing dikes are underlain with Bay Mud, a highly compressible soil; therefore, a nominal foundation excavation plan is assumed. Also, to accommodate construction on deep Bay Mud in one phase rather than 2 or 3 over the course of several years, approximately 2,026,280 linear feet of wick drains will be necessary.

2.1.13 FRM Option 5 – Alviso RR and WPCP South, 100-year event

Option 5 (**Figure 9 – FRM Option 5)** cost estimates were extrapolated based on the analyses of the initial seven options. No quantities were developed. This option involves the construction of new levees from existing high ground West of Alviso along the existing dikes bordering pond A12, and east along the existing UPRR line to Grand Blvd. The levees will follow Grand Blvd to the Artesian Slough levees and go north around the outside of the Don Edwards Center and there tie into a new tide gate.

New levees will be constructed from the tide gate along the existing pond A18 alignment, tying into the Coyote Creek Bypass northeast of the WPCP sludge ponds. The levees, tide gate, and closure structure at the UPRR will be construction to an elevation of 15.85 feet, plus allowances for settlement.

Due to the concerns regarding the structural integrity of the existing dikes, this option involves the replacement of the entire dike alignment. Additional geotechnical studies will be required to identify reach segments to determine how much existing dike material is suitable for re-use.

The new levee would have a crown width of 16 feet for the entire length as well as 3:1 side slopes and would provide a 100-year level of protection. Project geotechnical data indicates the existing dikes are underlain with Bay Mud, a highly compressible soil; therefore, a nominal foundation excavation plan is assumed. Also, to accommodate construction on deep Bay Mud in one phase rather than 2 or 3 over the course of several years, wick drains will be necessary.

2.1.14 FRM Option 6 – Alviso South and WPCP South, 100-year event

Option 6 (**Figure 10 – FRM Option 6)** cost estimates were extrapolated based on the analyses of the initial seven options. No quantities were developed. This option involves the construction of levees from existing high ground West of Alviso south to the town of Alviso. The new levee alignment will follow the outer boundary of Alviso, go along Grand Blvd to the East and tie into a new tide gate north of the don Edwards Center at Artesian Slough.

New levees will be constructed from the tide gate along the existing pond A18 alignment, tying into the Coyote Creek Bypass northeast of the WPCP sludge ponds. The levees, tide gate, and closure structure at the UPRR will be construction to an elevation of 15.85 feet, plus allowances for settlement.

Due to the concerns regarding the structural integrity of the existing dikes, this option involves the replacement of the entire dike alignment. Additional geotechnical studies will be required to identify reach segments to determine how much existing dike material is suitable for re-use.

The new levee would have a crown width of 16 feet for the entire length as well as 3:1 side slopes and would provide a 100-year level of protection. Project geotechnical data indicates the existing dikes are underlain with Bay Mud, a highly compressible soil; therefore, a nominal foundation excavation plan is assumed. Also, to accommodate construction on deep Bay Mud in one phase rather than 2 or 3 over the course of several years, wick drains will be necessary.

2.1.15 FRM Option 7 – Alviso North and WPCP South, 25-year event

Option 7 (**Figure 11 – FRM Option 7**) cost estimates were extrapolated based on the analyses of the initial seven options. No quantities were developed. This option involves the removal and reconstruction of levees from existing high ground West of Alviso along the existing dikes bordering ponds A12, 13, and 16. The levees will tie into a new tide gate north of the Don Edwards Center at Artesian Slough.

New levees will be constructed from the tide gate along the existing pond A18 alignment, tying into the Coyote Creek Bypass northeast of the WPCP sludge ponds. The levees, tide gate, and closure structure at the UPRR will be construction to an elevation of 14.96 feet, plus allowances for settlement.

Due to the concerns regarding the structural integrity of the existing dikes, this option involves the replacement of the entire dike alignment. Additional geotechnical studies will be required to identify reach segments to determine how much existing dike material is suitable for re-use.

The new levee would have a crown width of 16’ for the entire length as well as 3:1 side slopes and would provide a 25-year level of protection. Project geotechnical data indicates the existing dikes are underlain with Bay Mud, a highly compressible soil; therefore, a nominal foundation excavation plan is assumed. Also, to accommodate construction on deep Bay Mud in one phase rather than 2 or 3 over the course of several years, wick drains will be necessary.

2.1.16 FRM Option 8 – Alviso North and WPCP South, 200-year event

Option 8 (**Figure 12 – FRM Option 8**) cost estimates were extrapolated based on the analyses of the initial seven options. No quantities were developed. This option involves the removal and reconstruction of levees from existing high ground West of Alviso along the existing dikes bordering ponds A12, 13, and 16. The levees will tie into a new tide gate north of the Don Edwards Center at Artesian Slough.

New levees will be constructed from the tide gate along the existing pond A18 alignment, tying into the Coyote Creek Bypass northeast of the WPCP sludge ponds. The levees, tide gate, and closure structure at the UPRR will be construction to an elevation of 16.27 feet, plus allowances for settlement.

Due to the concerns regarding the structural integrity of the existing dikes, this option involves the replacement of the entire dike alignment. Additional geotechnical studies will be required to identify reach segments to determine how much existing dike material is suitable for re-use.

The new levee would have a crown width of 16 feet for the entire length as well as 3:1 side slopes and would provide a 200-year level of protection. Project geotechnical data indicates the existing dikes are underlain with Bay Mud, a highly compressible soil; therefore, a nominal foundation excavation plan is assumed. Also, to accommodate construction on deep Bay Mud in one phase rather than 2 or 3 over the course of several years, wick drains will be necessary.

2.2 Ecosystem Restoration Measures

A series of restoration measures were developed that include a combination of transitional habitat construction, tidal marsh restoration, and recreation mitigation. Transitional habitat construction and pond restoration features are summarized in the following section.

2.2.1 Transitional Habitat

Three levels of transitional habitat were considered: large-ecotone with 100:1 slopes, which would provide the most expansive habitat; medium-ecotone incorporating 30:1 slopes; and a 50-foot-wide bench to provide for minimal amount of refugia immediately following construction. These are further described in **Table 2 – Transitional-Upland Slope Design**.

Table 2. Transitional-Upland Slope Design

ER Option	Design
50 Foot Bench	3:1 (H:V) front slope of the levee with a 50-foot wide bench at elevation 9.0 feet NAVD88 forms the transitional zone.
Medium Ecotone	30:1 (H:V) slope for the transitional zone. The zone begins at the approximate upgraded flood-control levee crest and maintains a 30:1 slope from the levee crest to EL 5.0 feet NAVD88. It is assumed that the upper slope of the transitional zone would be planted and hydro-seeded with a native seed mix.
Large Ecotone	100:1 (H:V) slope for the transitional zone. The zone begins at the approximate upgraded flood-control levee crest and maintains a 100:1 slope from the levee crest to EL 5.0 feet NAVD88. It is assumed that the upper slope of the transitional zone would be planted and hydro-seeded with a native seed mix.

The 30:1 and 100:1 (H:V) slopes in the Medium and Large Ecotone options represent idealized slopes. During final design and construction, the slopes would include some variation both in plan view to create a more natural shoreline and along the slope to create benches and shallow depressions to form pannes at a variety of elevations. The intent is to create a nuanced feature within the overall idealized slope to create an upland transitional zone with complexity.

2.2.1.1 Phasing

The initial stage fill for the transitional habitat along Pond A12 would be constructed between 2019 and 2020 during the FRM levee construction period.

The transitional habitat along Pond A18 would initiated during the FRM levee construction period and completed between the years 2023 and 2025 as fill becomes available.

2.2.2 Tidal Marsh Restoration

2.2.2.1 Overview

All alternatives include modifications to existing salt ponds to allow tidal flow between adjacent sloughs and the existing ponds, and support both ecosystem restoration and FRM functions. These modifications are discussed below. **Figures 13A through 13C – Pond Restoration Measures** illustrate the locations of the pond restoration features by anticipated construction year.

2.2.2.2 Outboard Dike Breaches

Outboard pond dike breaches are excavations through the perimeter dikes that open the pond to tidal inundation from the adjacent tidal sloughs. Breaches through the outboard dike and excavation of pilot channels through the outboard marsh leading to these breach sites would be placed at major historic tidal channel locations. Breach size would be determined based on the hydrologic relationship between the tidal channel and marsh drainage area and on data from tidal channels in mature marshes throughout the bay (ESA PWA 2012). Breaches are sized to long-term equilibrium dimensions to balance between excavation costs, scour potential, and tidal drainage, consistent with Design Guidelines for Tidal Wetland Restoration in San Francisco Bay (PWA, 2004). Dimensions are adjusted to provide a cross-section with side slopes of 4:1 to 5:1 and a bottom width of approximately 10 feet. On the inboard side of the dike, the breach excavation would extend to the dike toe.

The breaches are expected to be undersized compared to restored tidal flows due to the larger tidal prism of the existing subsided ponds. Large tidal flows are expected to scour and enlarge the breaches until equilibrium between the tidal prism and channel dimensions is reached. Over time, the tidal prism would decrease as the pond fills in due to sedimentation and vegetation establishment. During final design, the breach cross-sectional area will be revised to size individual breaches based upon estimated drainage area at each individual breach.

Breach design details and construction years are described in **Table 3 – Outboard Dike Breach Cross-Sections** below.

Table 3. Outboard Dike Breach Cross-Sections

Watersheds	Number of Breaches	Drainage Area [ac]	Breach Invert Elevation [ft NAVD]	Breach Top Width (@ EL 7.5 feet) [ft]	Breach End Const. Year
Pond A9	2	454	-8.6	190	2026
Pond A10	2	228	-6.0	140	2026
Pond A12 (1)	1	246	-6.3	145	2021
Pond A12 (2)	1	265	-6.5	150	2021
Ponds A13-15	1	914	-11.6	260	2031
North A18	1	116	-3.9	100	2026
Central A18	1	221	-5.9	135	2026
Southwest A18	2	258	-6.4	145	2026
East A18	1	255	-6.4	145	2026

*Cross Sectional Area below EL 7.5 feet NAVD88

2.2.2.3 Internal Pond Berm Breaches, Raising and Possible Lowering

Internal pond berms would be breached to reconnect historic channels and restore the hydrologic connections to the innermost ponds in the project footprint. Breach excavations would be sized in a similar manner to those applied to the outboard levees and would extend beyond the berm into the remnant historic channel. Internal pond breach details are shown in **Table 4 – Internal Berm Breach Cross-Sections.** During final design, the breach cross-sectional area will be revised to size individual breaches based upon estimated drainage area at each individual breach.

Table 4. Internal Berm Breach Cross-Sections

Internal Berm Breach	Total Drainage Area [ac]	Breaches [#]	Average Drainage Area [ac]	Average Invert Elevation [ft NAVD]	Average Top Width* [ft]	Internal Breach End Const. Year
Pond A9/A14	92	2	46	-1.6	65	2031
Pond A12/11	n/a	1	n/a	-1.6	125	2021
Pond A10/A11	203	1	203	-5.6	140	2026
Ponds A13-15	647	11	59	-2.1	75	2031

*Top Width at EL 7.5 feet NAVD88
**Cross-sectional Area below elevation 7.5 feet NAVD88

Berms in adjacent ponds not yet breached will be temporarily raised to temporarily provide increased flood protection during pond construction. Assumed design sections for raised internal berms include a 10 to 15 feet wide crest at elevation 9.8 feet, with 2:1 to 3:1 side slopes. In the future, existing internal berms may also be lowered in some areas during the same excavation work to create wave-break berms to limit wave action, enhance sedimentation, and create vegetated marsh habitat on the berm crests in the short term while the ponds develop from mudflat to vegetated marsh. No new berms are proposed. Details of internal berm raising and construction years are provided below in **Table 5 – Internal Berm Interim Raising.**

Table 5. Internal Berm Interim Raising

Internal Berm Raise	Length of Berm Raise [ft]	Crest Elevation [ft NAVD]	Internal Berm Raise End Construction Year
Pond A12 North & Northwest	4,590	9.8	2021
Pond A9 East	3,440	9.8	2026
Pond A11 North and East	4,900	9.8	2026

2.2.2.4 Borrow Ditch Blocks

Material excavated from the existing levees and berms will be used to construct ditch blocks, which would inhibit flow through existing borrow ditches, promote scour and flow through the remnant historic and starter channels, and provide pickle weed habitat. Ditch blocks would be located so that the borrow ditch on both sides of the block connect to a breach, also reducing the potential for fish stranding.

Ditch blocks are assumed to be trapezoidal in section with a top with of about 50 feet, crest at elevation 7.5 feet NAVD, and 5:1 or flatter side slopes. The ditch blocks would extend across the borrow ditch adjacent to the existing levee (generally at least 100 feet from the inboard levee crest). We assume that at least 26 ditch blocks would be constructed – one adjacent to each outboard levee and internal berm breach.

2.2.2.5 Pilot Channels

Pilot channels would be excavated through the outboard marsh to connect each outboard levee breach to the adjacent tidal slough. The new channels would be located at historic channel locations. Similar to the outboard breaches, pilot channels would be sized to the long-term channel depth and 60-80% of the long-term channel width, with the side slopes of approximately 3:1. The resulting channels are somewhat undersized to reduce the amount of excavation and are expected to naturally scour and enlarge. Marsh vegetation will be excavated to the root zone to reduce the resistance to pilot channel bank erosion.

The assumed cross-section dimensions and lengths for each pilot channel are presented in **Table 6 – Pilot Channel Cross-Section Dimensions and Lengths** below.

Table 6. Pilot Channel Cross-Section Dimensions and Lengths

Watersheds	Drainage Area [ac]	Pilot Channel Invert Elevation [ft NAVD]	Pilot Channel Top Width* [ft]	Pilot Channel Length** [ft]	Pilot Channel End Const. Year
Pond A9	454	-8.6	135	1,480	2026
Pond A9 (West)	N/a	-8.6	135	1480	2026
Pond A10	228	-6.0	100	265	2026
Pond A10 (West)	n/a	-6.0	100	300	2026

Watersheds	Drainage Area [ac]	Pilot Channel Invert Elevation [ft NAVD]	Pilot Channel Top Width* [ft]	Pilot Channel Length** [ft]	Pilot Channel End Const. Year
Pond A11	246	-6.3	100	155	2026
Pond A12	265	-6.5	105	575	2021
Ponds A13-15	914	-11.6	180	1,110	2031
North A18	116	-3.9	70	130	2026
Central A18	221	-5.9	95	175	2026
Southwest A18	258	-6.4	100	330	2026
East A18	255	-6.4	100	490	2026

* Top Width at EL 7.5 feet NAVD88
**Length assumes that 50 feet from outboard levee crest is excavated as part of the outboard levee breach

3.0 Locally Preferred Plan

3.1 Flood Risk Management Levees

The LPP involves the construction of FRM levees at a 100-year LOP (1% ACE) along with a medium fill ecotone built to a 30:1 slope in Pond A18 only. Pond restoration measures as detailed above are included in the LPP for Pond A18 only. The LPP is summarized in **Table 7 – Locally Preferred Plan Summary** and the following sections.

Table 7. Locally Preferred Plan Summary

Section	Station Range	Side Slopes (H:V)	Average Height (including settlement) (ft.)	Crown Width (ft.)	Wick Drains?	30:1 Ecotone?
Sec 1	0+00 to 43+80	3:1	16.7	16	No	Yes
Sec 2	43+80 to 65+00	3:1	16.7	16	No	No
Sec 3	65+00 to 94+75	3:1	19.7	16	Yes	No
Sec 4	94+75 to 150+00	3:1	19.7	16	Yes	Yes
Sec 5	150+00 to 197+75	3:1	15.2	16	No	Yes

3.1.1 Alignment

The Locally Preferred Plan includes an Alviso North, WPCP South alignment with a closure structure across Artesian Slough. On the Alviso side, levees would be constructed from STA 0+00 at existing high ground West of Alviso along the existing dikes bordering ponds A12, 13, and 16. The levees will tie into a new tide gate north of the Don Edwards Center at Artesian Slough (reference drawings) at approximate STA 94+75. On the WPCP side, new levees will be constructed from the tide gate, along the existing dikes of Pond A18, and will tie into the existing levees at Coyote Creek north of the WPCP sludge ponds at STA 197+75 (**Sheets C-01 to C-54, LPP Plans, Profiles and Sections**).

3.1.2 Design, Considerations, and Construction

The levee will be built to the elevations shown in **Table** 7 to achieve a post-settlement design elevation of 15.2[1] feet. The levee side slopes will be 3H:1V and the crown will be 16 feet wide. A 12-foot wide levee crest access road will be constructed of 6-inch thick gravel. During design, settlement was accounted for and reflected in the quantities, estimate, and plansets. Settlement was determined using Figure 3-1 of the Geotechnical Appendix (Appendix O).

Construction activities include clearing and grubbing and stripping of work areas including the permanent and temporary construction easement. Hydroseeding is included for erosion protection along finished grades. Foundation preparation for the new FRM levee will include degrading the existing levee to elevation 0 ft and excavating an inspection trench along the centerline of the levee. The inspection trench will be 4 feet deep with 1:1 side slopes and have a bottom width of 8 feet. All excavation is assumed to have a 50% fill suitable for re-use on the new levees. Excess cut would be stored onsite for the construction of the ecotone.

The deep Bay Mud will also require the use of wick drains during construction to hasten time to consolidate and increase strength of foundation soils. Wick drains will have 4-foot mid point spacing. Wick drains will extend 5' on each side of the levee footprint as well as extend 5 feet past the lower extent of the Bay Mud. Corrugated metal piping will span horizontally across the levee footprint and be attached to each wick drain to drain the water. Wick drains will be required from approximately STA 65+00 to 94+75. The design basis for requiring wick drains is related to the thickness of Bay Mud and the height of new fill being constructed (Appendix O).

3.2 Closure Structures

3.2.1 Railroad Closure

The railroad structure would be a Miter Leaf Swing Gate measuring approximately 50 feet x 12 feet and constructed to an elevation of 16 feet. The structure would be constructed on a concrete pile deep foundation system due to the bay mud in the area.

3.2.2 Artesian Slough Closure

The Artesian Slough closure would consist of a concrete headwall measuring approximately 100 feet x 20 feet and constructed to an elevation of 16 feet. The structure would include two 72-inch discharge pipes to release flow from Artesian Slough. The pipes will include duckbill check valves to prevent tidal waters from flowing into the slough. The structure would be supported on a concrete pile deep foundation system due to the deep Bay Mud in the vicinity.

[1] Following development of the final array of alternatives, determination of the design water surface (and top of levee) was refined and revised. The 100-year LOP levee elevations for the LPP are therefore different than the 100-year elevations of the final array.

3.3 Ecosystem Restoration

3.3.1 Transitional Habitat Alignment

The ecotone alignment would generally follow the levee alignment and be constructed on and adjacent to the waterside slope of the new FRM levee. The extent of ecotone in the western reach of the alignment is within Pond A12 and 13 from STA 0+00 to 43+80, and in the eastern reach of the alignment within Pond A18 from STA 94+75 to 197+75 (**Sheets C-01 to C-54, LPP Plans, Profiles and Sections**).

3.3.2 Design, Consideration, and Construction

The ecotone will be constructed to an elevation of 16 feet at its boundary with the new FRM levee under the LPP. The ecotone will have a 30:1 slope which transitions to a 3:1 slope at approximately elevation 5 feet. Hydroseeding is included for erosion protection. The ecotone would be constructed with excess cut material left from FRM construction, readily available fill within the salt pond area, and no cost fill generated by local construction/maintenance projects identified by the non-federal sponsor. Fill material that is generated from the degradation of the existing alignment, and that is not reusable for the new FRM levee will be used to construct the bench.

3.3.3 Pond/Tidal Marsh Restoration

Pond Restoration will occur under the LPP. Pond restoration will include a series of inboard and outboard dike breaching, construction of pilot channels, temporary heightening of inboard levees, and the construction of ditch blocks to block currently existing channels in restored ponds. The pond restoration measures will be constructed as detailed above in Section 2.2. Construction will utilize fill available onsite, such as fill from existing berms, and any dredging that may occur.

4.0 National Economic Development Plan

4.1 Flood Risk Management Levees

The NED Plan involves the construction of FRM levees built to an elevation containing the 25-year flood event along with the no fill Ecosystem Restoration alternative 50-foot wide bench. Pond restoration measures as detailed above are also included in the NED Plan. The NED Plan is summarized in the table below and the following sections.

Table 8. National Economic Development Plan Summary

Section	Station Range	Side Slopes (H:V)	Average Height (including settlement) (ft.)	Crown Width (ft.)	Wick Drains?	50 foot Bench?
Sec 1	0+00 to 43+80	3:1	14.5	16	No	Yes
Sec 2	43+80 to 65+00	3:1	14.5	16	No	No
Sec 3	65+00 to 94+75	3:1	17.0	16	Yes	No
Sec 4	94+75 to 150+00	3:1	17.0	16	Yes	Yes

Section	Station Range	Side Slopes (H:V)	Average Height (including settlement) (ft.)	Crown Width (ft.)	Wick Drains?	50 foot Bench?
Sec 5	150+00 to 197+75	3:1	13.7	16	No	Yes

4.1.1 Alignment

The NED Plan includes an Alviso North, WPCP South alignment with a closure structure across Artesian Slough. On the Alviso side, levees would be constructed from STA 0+00 at existing high ground West of Alviso along the existing dikes bordering ponds A12, 13, and 16. The levees will tie into a new tide gate north of the Don Edwards Center at Artesian Slough (reference drawings) at approximate STA 94+75. On the WPCP side, new levees will be constructed from the tide gate, along the existing dikes of Pond A18, and will tie into the existing levees at Coyote Creek north of the WPCP sludge ponds at STA 197+75 (See **Sheets C-01 to C-54, NED Plans, Profiles and Sections**).

4.1.2 Design, Considerations, and Construction

The levee will be built to the elevations shown in **Table 8** to achieve a post-settlement design elevation of 13.5 feet. The levee side slopes will be 3H:1V and the crown will be 16 feet wide. A 12-foot wide levee crest access road will be constructed of 6-inch thick gravel. During design, settlement was accounted for and reflected in the quantities, estimate, and plansets. Settlement was determined using Figure 3-1 of the Geotechnical Appendix (Appendix O).

Construction activities include clearing and grubbing and stripping of work areas including the permanent and temporary construction easement. Hydroseeding is included for erosion protection along finished grades. Foundation preparation for the new FRM levee will include degrading the existing levee to elevation 0 ft and excavating an inspection trench along the centerline of the levee. The inspection trench will be 4 feet deep with 1:1 side slopes and have a bottom width of 8 feet. All excavation is assumed to have a 50% fill suitable for re-use on the new levees. Excess cut would be stored onsite for the construction of the ecotone.

The deep Bay Mud will also require the use of wick drains prior to and during construction to reduce settlement time and strengthen soil to increase the rate of construction. Wick drains will have 4 foot mid-point spacing. Wick drains will extend 5 feet on each side of the levee footprint as well as extend 5 feet past the Bay Mud depth. Corrugated metal piping will span horizontally across the levee footprint and be attached to each wick drain to drain the water. Wick drains will be required from approximately STA 65+00 to 150+00. The design basis for requiring wick drains is related to the thickness of Bay Mud and the height of new fill being constructed (Appendix O).

4.2 Closure Structures

4.2.1 Railroad Closure

The rail road structure would be a Miter Leaf Swing Gate measuring approximately 50' x 12' and constructed to an elevation of 15 feet. The structure would be constructed on a deep pile foundation due to the bay mud in the area.

4.2.2 Artesian Slough Closure

The Artesian Slough closure would consist of a concrete headwall measuring approximately 100 feet x 20 feet and constructed to an elevation of 15 feet. The structure would include two 72 inch discharge pipes to release flow from Artesian Slough. The pipes will include duckbill check valves to prevent tidal waters from flowing into the slough. The structure would be supported on a deep pile foundation due to the deep bay mud in the vicinity.

4.3 Ecosystem Restoration

4.3.1 Transitional Habitat Alignment

The bench alignment would generally follow the levee alignment. It would be constructed along the western side of the alignment at Pond A12, 13, and 16 from STA 0+00 to 43+80 as well as along pond A18 from STA 94+75 to 197+75 (See **Sheets C-01 to C-54, NED Plans, Profiles and Sections**).

4.3.2 Design, Consideration, and Construction

The bench will be constructed to an elevation of 9.00 feet. The bench will span 50 feet before transitioning to a 3:1 slope to meet exiting grade. Hydroseeding is included for erosion protection. The bench and restoration would be constructed with cut material from the degradation of the existing levee and levee foundation excavation.

4.3.3 Pond/Tidal Marsh Restoration

Pond Restoration will occur under the Locally Preferred Plan. Pond restoration will include a series of inboard and outboard levee breaching, construction of pilot channels, temporary heightening of inboard levees, and the construction of ditch blocks to block currently existing channels. The pond restoration measures will be constructed as detailed in Section 2.2. Construction will utilize fill available onsite, such as fill from existing berms, and any dredging that may occur.

5.0 Recreation Mitigation

5.1 Bridges

Both the NED and LPP will require mitigation for recreation facilities currently in place in the project area. To provide access for cyclists, joggers, etc., the levees will require bridges at the rail road and Artesian Slough closures. The bridge at the railroad crossing will span approximately 380 feet with a width of 12 feet. The bridge at the Artesian Slough crossing will span approximately 100 feet with a width of 12 feet. Representative details for the rail road bridge are shown in **Sheets D-05 and D-06 of the NED and LPP Plans, Profiles and Sections**. Representative details for the Alviso Slough crossing are shown in in **Sheets D-02 to D-04 of the NED and LPP Plans, Profiles and Sections**. Typical bridge construction has been assumed for the purposes of this study, as in-depth consideration of use, capacity, and architectural requirements will need to be determined during the pre-construction engineering and design (PED) phase. Quantity development and assumptions are further discussed in Section 8.0.

5.2 Bay Trails

For both the NED and LPP, existing recreational trails will require reconstruction and improvement due to FRM and ER construction. Bay trails will be designed to CalTrans standards (Highway Design Manual Chapter 1000, Bicycle Transportation Design) as Class I Bikeways. The recreational trails will be a total length of approximately 22,000 feet long. They will be constructed to a paved width of 10' feet with 3 foot shoulders of all-weather material (total width of 16 feet). For this study, it is assumed compacted dirt is sufficient for this purpose. Clearing and grubbing will occur over the work area, including the 16 food wide trail and 10 foot easements on either side for construction. Stripping will occur over the entire 16 foot width of the trail.

6.0 Real Estate

For the Locally Preferred Plan, acquisition of approximately 900 acres currently owned by the City of San José are allocated to ecosystem restoration, with approximately 54 acres for levee easements, 7 acres of permanent road easements, and 52 acres of temporary work easements. These acquisitions are currently split with approximately 31 parcels, more or less. The non-Federal sponsor is responsible for procurement of all lands, easements, relocations, rights-of-way, and disposal areas (LERRDs) that are necessary for construction, operation, and maintenance of the project. Potential real estate needs are described in the following sections.

6.1 Easements and R/W Requirements

Maintenance easements will be required for the proposed project. Levee maintenance and inspection will likely be performed from toe of the proposed levee, but may be accomplished from the levee crown. 15 feet from the landside toe of proposed levee has been designated as maintenance (permanent) easement. In addition to maintenance easements, utility relocation may require easement acquisition, depending on the placement of the relocated utilities and overhead/underground utilities.

Temporary construction easements will also be required for this project, and have been assumed to be 15 additional feet beyond the limits of the maintenance easement. In areas where the landside toe of the proposed levee lands within existing structures or property, there may be an opportunity to minimize required temporary easements by performing construction activities on the levee crown. For the purposes of this study, in areas where there was minimal infringement of temporary easement on existing property/structures, the temporary easement was reduced in width. This variance will require further investigation during final design.

Permanent and temporary construction easements are detailed on **Sheets C-01 through C-20 of the NED and LPP Plans, Profiles and Sections**

6.2 Borrow Locations

Borrow material from sources other than what will be derived from the degradation of existing levees is required to complete the levee construction. The sponsor will be required to provide 960,000 cubic yards of borrow to construct the LPP FRM levee. The borrow is anticipated to cover approximately 54 acres in at the currently identified borrow sites; Upper Llagas Creek, Upper Guadalupe River and Permanente Creek. Upper Llagas creek is the borrow site that is the furthest from the Shoreline project at 30 miles one-way. For cost estimating purposes, it was conservatively assumed that all levee borrow will be delivered via a 60 mile round trip. Upper Llagas Creek and Upper Guadalupe River are active USACE projects for which the sponsor is required to obtain the necessary real estate and would be eligible to receive credit under LERRD's. Permanente Creek is a non-federal project requiring a borrow easement for approximately 22 acres.

The non-Federal sponsor will secure sufficient fill to substantially construct restoration features prior to the initiation of construction. It is assumed this restoration fill will be placed within the project boundaries, and will have no purchase cost. Costs to cover rehandling of stockpiles materials and construction of restoration fills have been included in the LPP cost estimate.

6.3 Disposal and Storage Area

There is no need for disposal areas. All material that cannot be used as levee fill will be used as common fill within the project footprint. Common fill is expected to be used for construction of the bench (NED) or ecotone (LPP). No excess material is anticipated that would require on-site storage or that would require off-site disposal.

6.4 Staging Area

Potential staging areas have been identified around the project site for the NED and LPP alternatives. Due to the use of the same alignment, staging areas are the same for both plans (**Sheet G-03, NED and LPP Plans, Profiles and Sections**).

7.0 Relocations and Modifications

7.1 Overview

In total, there are over 80 known utilities within the study area that may be impacted by construction of flood risk management and environmental restoration features. Only four utility crossings are known to cross the alignment of the new flood control levee alignment. Utilities operated by the WPCP comprise of a large portion of the existing utilities potentially impacted. The WPCP owns approximately 61 of the more-than 80 utilities in the area. The majority of the WPCP's 61 known utilities in the project area are sited along both sides of Artesian Slough between the WPCP and the Don Edwards Center. Storm drains, sanitary sewers, and other utilities potentially conflict on the west and east side of Alviso and along Grand Blvd. These utilities are described in the Existing Utilities Information Technical Memorandum dated 29 September 2011 (**Appendix A**).

7.2 LPP and NED

Due to the same alignment, utility relocation/modification needs for the NED and LPP are identical. The utility relocation and modifications that apply to the NED and LPP alignment are summarized below:

- A siphon near STA 76+00 was installed in 2012 and maintains flow through the existing inboard dike to New Chicago Marsh. The siphon will be modified to allow for means of positive closure during flood events.
- Approximately 685 feet of an underground electrical supply leading to the SCWD weir at approximately STA 95+00 will need to be relocated to an overhead configuration.
- A culvert near STA 96+00 that maintains flow from Artesian Slough to a small mitigation area near the southwest extent of Pond A18. The culvert will be replaced to maintain existing functionality and include a means of positive closure during flood events.
- 5 existing PG&E power towers run through Pond A18 and may require in-place erosion protection due to potential changes in hydraulics caused by levee, ecotone, bench, or pond restoration construction. Overhead clearance of the new levee (STA 130+00) is substantial enough to not impact levee construction.
- The existing rail road bridge to the north of the project will require approximately 8,400 tons of rock protection due to potential changes in hydraulics caused by levee, ecotone, bench, or pond restoration construction.

8.0 Development of Construction Quantities

8.1 Levee and Transitional Habitat Quantities

Quantities were developed at a feasibility level of design for each alternative. Quantities were based on output from Civil3D as well as typical cross sections determined from average levee heights and design geometry. Hand calculation sheets including geometry and sample calculations are found in **Figures 14 - 27**. Fill volumes include settlement. Build to elevations (i.e. fill heights) for the LPP and NED levees are shown in the plan set for each levee. Quantities for the NED levees and bench are found in **Quantities Tables 1 and 2** respectively, LPP levees and ecotone in **3 and 4.**

8.2 Pond Restoration Quantities

AutoCAD developed cross-sections and aerial topography (LiDar) of the majority of the salt ponds within the Shoreline Study area were used to develop quantities. Areas in which there was no LiDar available, assumed values for levee geometry were used. Hand calculation sheets including geometry and sample calculations are included in **Figures 28-31**. Pond restoration quantities are found in **Quantities 5-9**.

8.3 Recreation Mitigation Quantities

8.3.1 Bay Trail Quantities

Quantities were developed based on a typical cross section. It was assumed that the Bay Trail would have a 10-foot paved width with 3-foot compacted dirt shoulders per CalTrans standards. Hand calculations are found in **Figure 32**. Bay Trail Quantities are found in **Quantities 10**.

8.3.2 Bridge Quantities

Bridge quantities were developed based on a March 2006 Feasibility Report titled *Alviso Slough Pedestrian Bridge Feasibility Study, Bay Trail Reach 9B*, developed by CH2MHILL for the City of San Jose Department of Parks, Recreation and Neighborhood Services[2]. Quantities for the pedestrian bridges in this report were scaled based on length to become a representative sample of the pedestrian bridges included in the Shoreline Project, acceptable for cost estimating purposes. Bridge restoration quantities are found in **Quantities 11**.

9.0 Cost Estimates

Construction costs was developed using MII (MCACES) software and is summarized in **Table 9**. Costs for each applicable element include 33% for contingency. The contingency was established at the 2013 Cost and Schedule Risk Assessment.

Table 9. Project First Cost Summary

Element	NED/NER	LPP
Real Estate	$14,600,000	$14,700,000
FRM Features	$52,136,000	$63,436,000
Bank Stabilization	$1,074,000	$1,074,000
Utility Relocations	$397,000	$397,000
Transitional Habitat	$0	$29,283,000
Pond Restoration	$8,216,000	$8,216,000
Recreation	$2,978,000	$2,978,000

[2] The Alviso Slough Pedestrian Bridge was identified by the non-Federal sponsors as a suitable go-by for estimating for the Shoreline Study.

Preconstruction Engineering and Design	$14,726,000	$22,893,000
Construction Management	$7,186,000	$11,267,000
Monitoring	$1,769,000	$1,769,000
Adaptive Management	$6,618,000	$6,618,000
Total	$109,700,000	$162,631,000

10.0 Value Engineering

A Value Engineering (VE) study, sponsored by the Corps and facilitated by Value Management Strategies, Inc., was conducted for the Shoreline Study in Sacramento, California April 2-5, 2012. The VE study evaluated the initial array of FRM options (FRM Options 1A through 4), with the objective of confirming the process by which the PDT arrived at the array of alternatives, and to make recommendations for improving the design and evaluation of alternatives. The Revised draft Value Engineering Report, dated May 3, 2012, and provided the following statement of concurrence:

"Based on the information provided, it appears that the Project Delivery Team (PDT) considered an adequate range of alternatives and the process used to arrive at the array of alternatives (Options 1A, 1B, 1C, 2, 3, 4, and non-structural)[3] *is reasonable."*

The VE study developed six alternatives for consideration by the PDT. The purpose of the six alternatives was to reduce project cost, reduce implementation schedule, and/or improve project performance. A summary of the recommended alternatives along with the PDT response is provided below.

1.1 Select Option 2 – 100-year as the final alignment; eliminate wick drains; reuse existing levees; do not remove them, just raise them with earth

Final plan selection will be based on the NED analysis and non-Federal sponsor preference. The elimination of wick drains will require additional analyses during the PED phase. While eliminating wick drains is technically feasible (based on known conditions), the time required to construct without eliminating pore pressure as a significant negative impact on the short-term level of protection.

If during the PED phase additional investigations and analyses indicate that the existing levees are suitable foundation for additional fill, they can be left in place.

[3] At the time the VE team reviewed the array of options, only the seven FRM options had been formulated. Subsequent to completion of the VE study, through coordination with the non-Federal sponsors, four additional FRM options were added to the final array, as discussed in Section 2.1.

1.2 Select Option 2 – 100-year as the final alignment; eliminate wick drains; reuse existing levees; do not remove them, just raise them using precast concrete units

Final plan selection will be based on the NED analysis and non-Federal sponsor preference. The elimination of wick drains will require additional analyses during the PED phase. While eliminating wick drains is technically feasible (based on known conditions), the time required to construct without eliminating pore pressure as a significant negative impact on the short-term level of protection.

Although the overall weight may be reduced by concrete, the bay mud is highly compressible and even small increases in stress over the existing stress condition may cause significant settlement and the need for wick drains may not be eliminated. The seepage risks may be increased by allowing a higher head on the existing levee without increasing the seepage path length. The reliability of the levee may not be improved significantly when compared to the existing levee fragility analysis. Higher reliability is a primary goal of the project so that damages are reduced. Differential settlement that may result as of construction sequencing and foundation differential bay mud thickness could result in differing crest elevations and preferred flood overtopping locations and would be difficult to re-grade to a uniform crest elevation.

1.3 Construct geofoam block core levees; eliminate wick drains

EPS block is a common practice in general soft ground construction (highway embankments, etc), not levee construction. Should the fill over the blocks become damaged or eroded the buoyancy resistance would be reduced, compounding an erosion problem into potential other problems. This recommendation can, however, be examined further during PED phase.

2.0 Limit crown width to 10 feet

While this is a valid potential way to reduce cost, it is quite common for levee crest widths to exceed 10 feet. Below are a few examples of levees with crest widths greater than 10 feet.

Feather River near Arboga, CA	Crest Width: 20 ft
Truckee Irrigation Canal Levee, near Fearnly, NV	Crest Width: 15 ft
Jones Track Levee near Stockton, CA	Crest Width: 28 ft
Natomas Levees near Sacramento, CA	Crest Width: 20 to 44 ft
Winslow Levees, near Winslow AZ	Crest Width: 22 ft
Guadalupe River Levees, near Alviso, CA	Crest Width: 20 ft
Coyote Creek Levees, near San Jose/Alviso, CA	Crest Width: 18 ft
San Mateo Bay Front Levees, San Mateo, CA	Crest Width: 12 to 18 ft
Roaring Sough Levee, CA	Crest Width: 30 ft

A performance change in reducing the crest width may include decreased flexibility if levee settles too much or sea level rise exceeds expectations (1-foot raise at 3:1 slopes would reduce the crest to 10 ft), and that emergency access and flood fighting would be reduced.

Additionally, loss of levee fill width would lead to shorter time for erosion to breach levee should erosion initiate.

3.0 Do not gravel top the levees; no vehicular access

The levee could become impassible during wet weather, making emergency access and flood fighting more difficult and could reduce levee performance. Levee surfaces now on the outer levees are not graveled and even during small rain events, light trucks are unable to pass the levee crest safely. The non-Federal sponsor has suggested a preference for gravel surfacing.

4.0 Consider a 12-hour-per-day construction operation to improve the schedule

Where the construction schedule is not controlled by the rate of foundation consolidation, this is a reasonable and effective method to reduce the overall construction schedule. This recommendation should be considered during PED phase.

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Figures

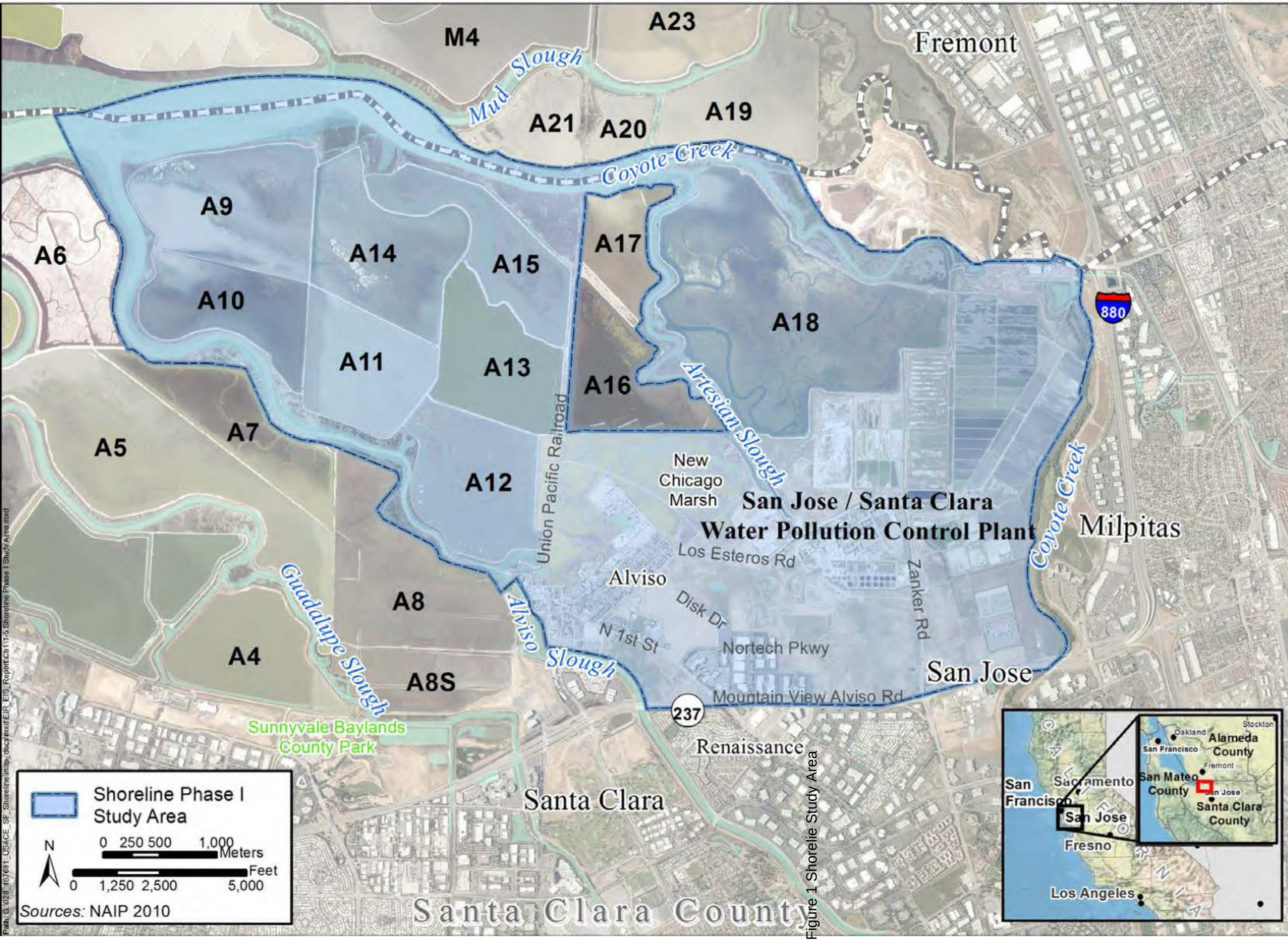

Figure 1 Shorelie Study Area

Alviso North, WPCP North, 200-Year
Plan View

Figure 2. Option 1A Plan View

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Alviso North, WPCP North, 100-Year
Plan View

Figure 3. Option 1B Plan View

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Alviso North, WPCP North, 50-Year Plan View

Figure 4. Option 1C Plan View

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Alviso North, WPCP North, 25-Year Plan View

Figure 5. Option 1D Plan View

Alviso North, WPCP South, 100-Year Plan View

Figure 6. Option 2 Plan View

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Alviso RR, WPCP North, 200-Year Plan View

Figure 7. Option 3 Plan View

Alviso South, WPCP South, 50-Year
Plan View

Figure 8. Option 4 Plan View

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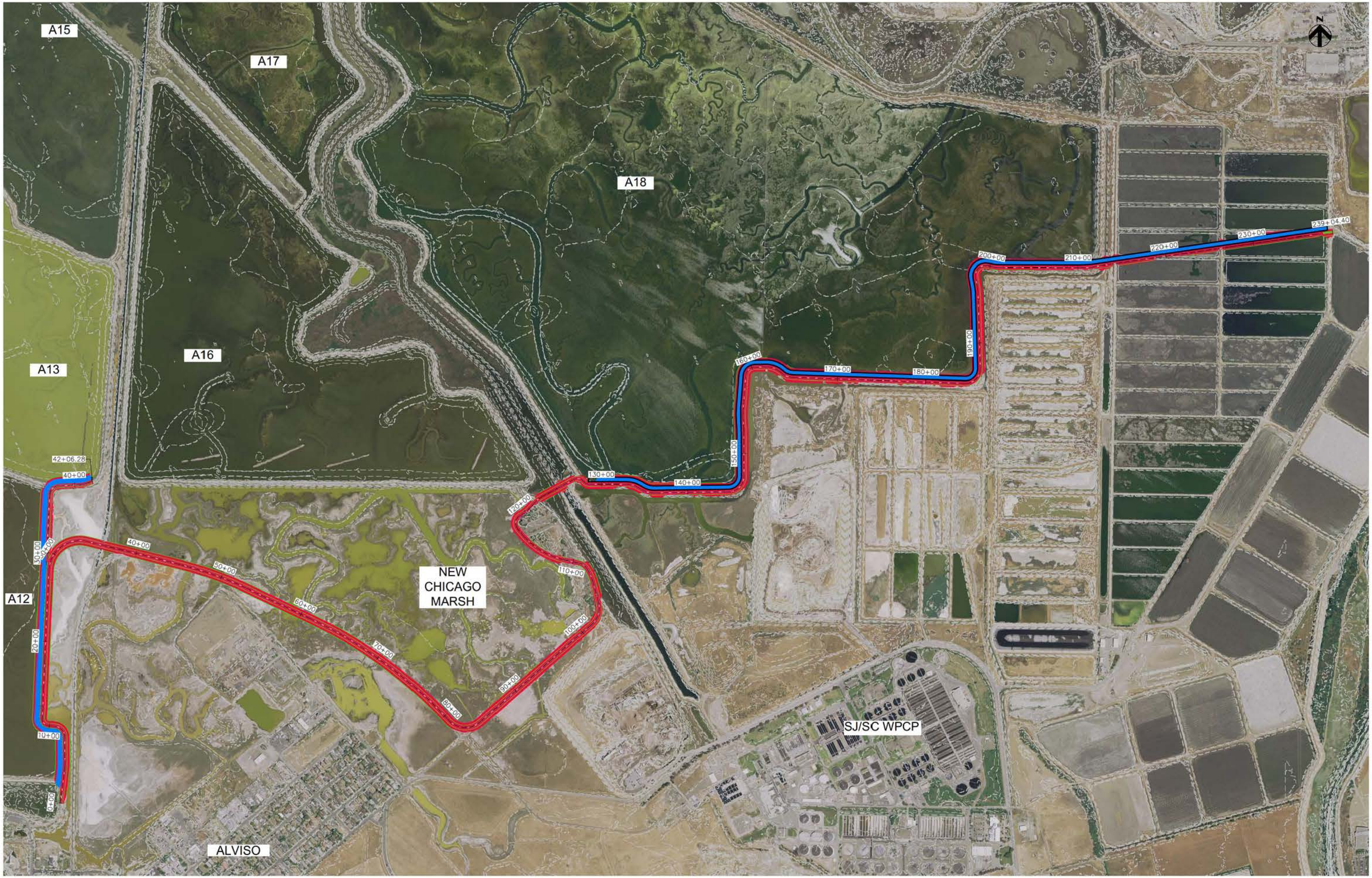

ALVISO RR WPCP SOUTH, 100-Yr
PLAN

Figure 9. Option 5 Plan View 01

HDR US Army Corps of Engineers

ALVISO SOUTH WPCP SOUTH, 100-Yr
PLAN

Figure 10. Option 6 Plan View

01

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C:\pwworking\sac\d0405412\Alviso South WPCP South 100yr.dwg, 10/18/2012 11:10:22 AM

ALVISO NORTH WPCP SOUTH, 25-Yr
PLAN

Figure 11. Option 7 Plan View 01

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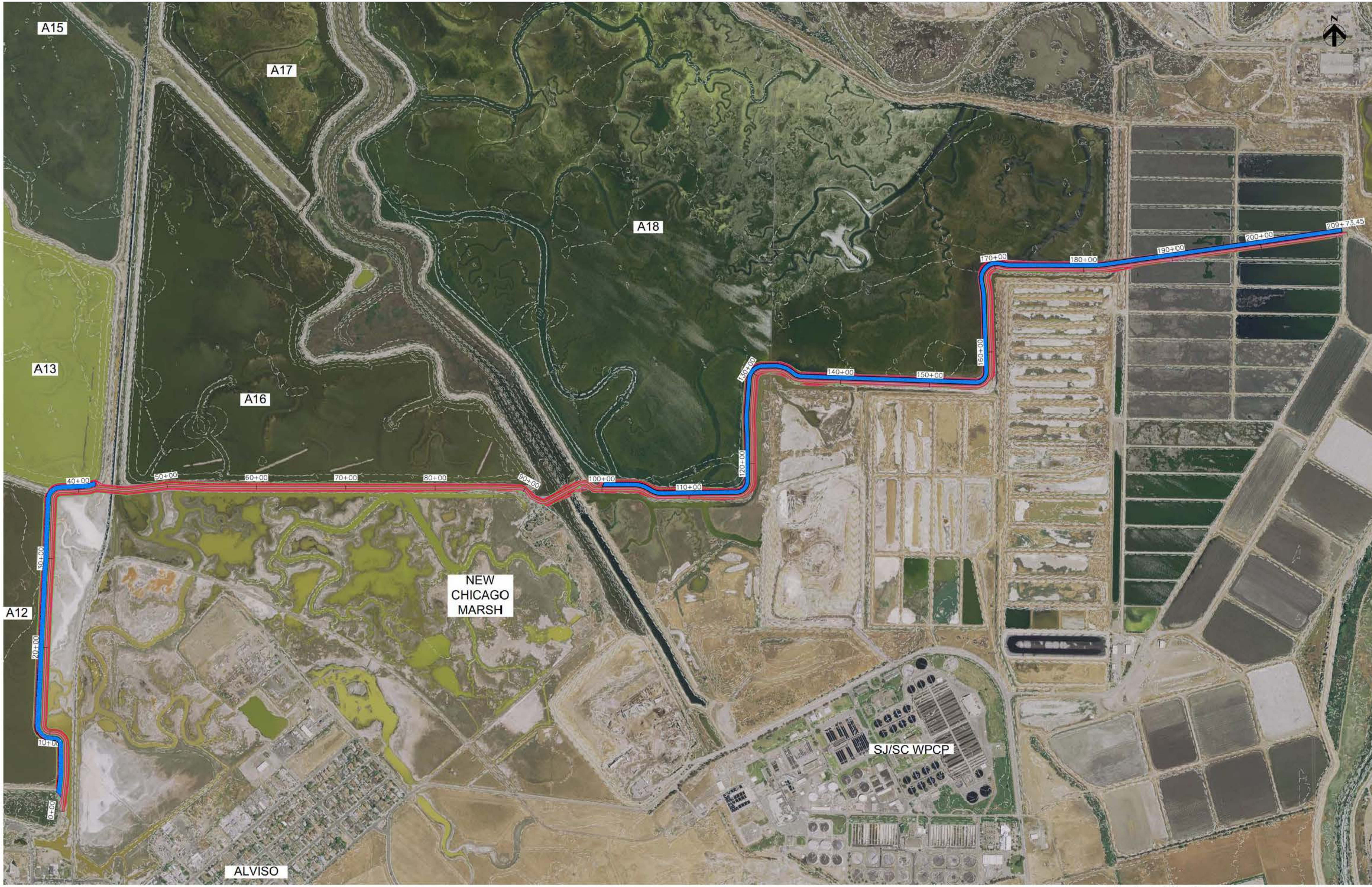

ALVISO NORTH WPCP SOUTH, 200-Yr
PLAN

Figure 12. Option 8 Plan View

01

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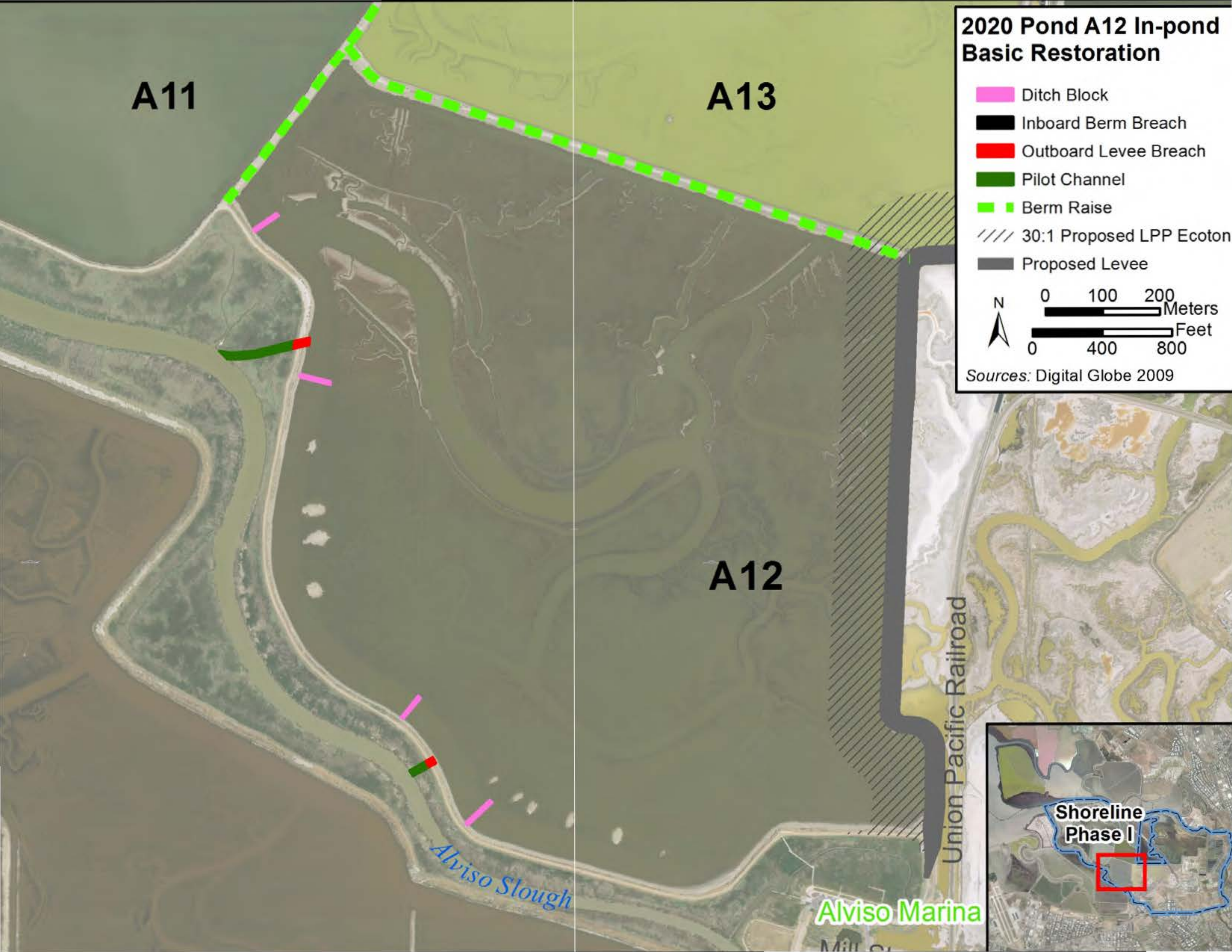


2020 Pond A12 In-pond Basic Restoration
Ditch Block
Inboard Berm Breach
Outboard Levee Breach
Pilot Channel
Berm Raise
30:1 Proposed LPP Ecoton
Proposed Levee
N
0 100 200 Meters
0 400 800 Feet
Sources: Digital Globe 2009
A11
A13
A12
Union Pacific Railroad
Alviso Slough
Alviso Marina
Shoreline Phase I

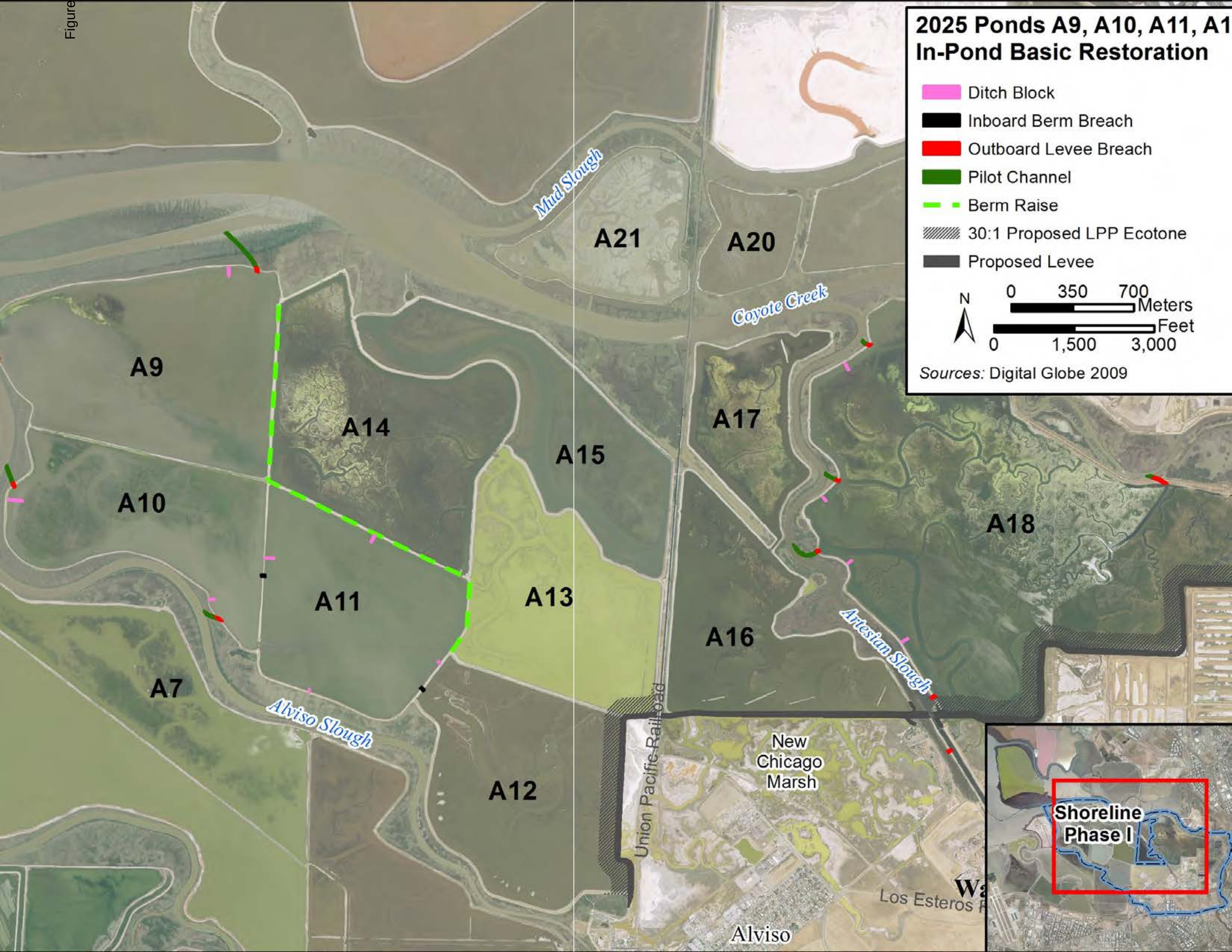
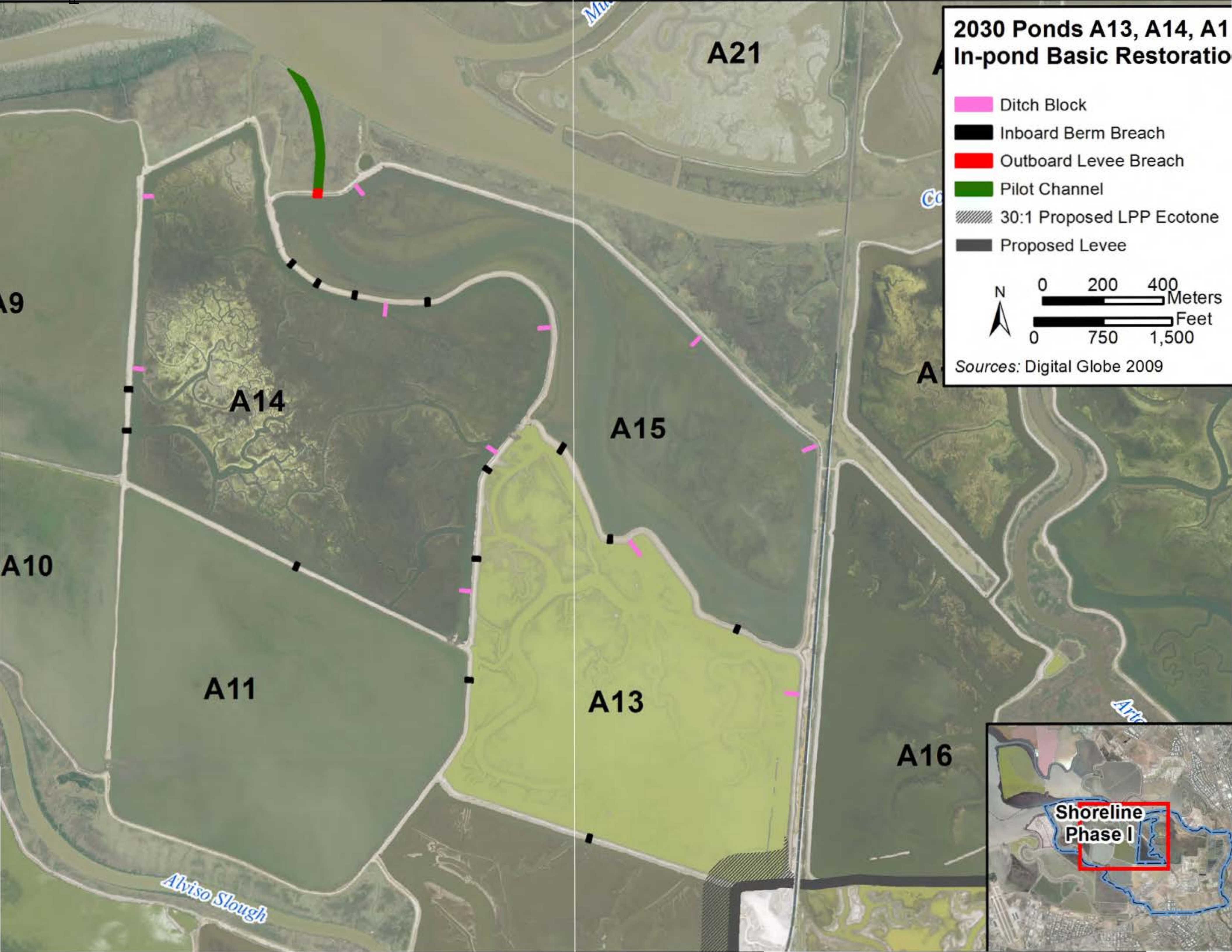


Figure
2025 Ponds A9, A10, A11, A1
In-Pond Basic Restoration
Ditch Block
Inboard Berm Breach
Outboard Levee Breach
Pilot Channel
Berm Raise
30:1 Proposed LPP Ecotone
Proposed Levee
N
0 350 700 Meters
0 1,500 3,000 Feet
Sources: Digital Globe 2009
Mud Slough
Coyote Creek
Artesian Slough
Alviso Slough
A21
A20
A9
A14
A15
A17
A10
A18
A13
A11
A16
A7
A12
Union Pacific Railroad
New Chicago Marsh
Los Esteros
Alviso
Shoreline Phase I


2030 Ponds A13, A14, A1
In-pond Basic Restoratio
Ditch Block
Inboard Berm Breach
Outboard Levee Breach
Pilot Channel
30:1 Proposed LPP Ecotone
Proposed Levee
0 200 400 Meters
0 750 1,500 Feet
N
Sources: Digital Globe 2009
A21
A9
A14
A15
A10
A11
A13
A16
Alviso Slough
Shoreline Phase I

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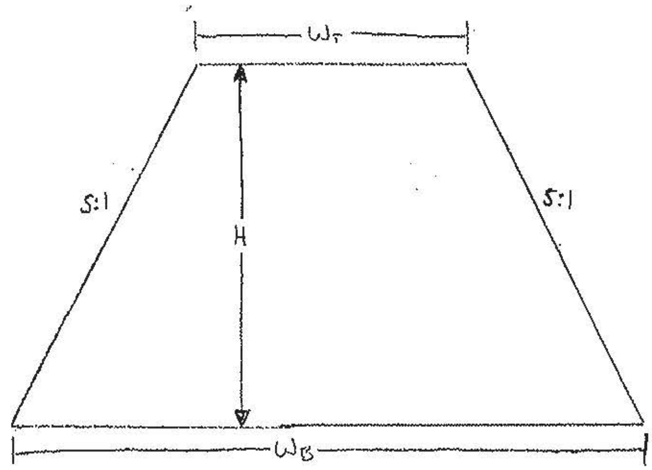
Project: Shoreline - FRM	Computed:	Date:	
Subject: Levee Volumes	Checked:	Date:	
Task:	Page:	of:	
Job #:	No:		



$$A_L = (H \times W_T) + \frac{H \times (H \times S)}{2} + \frac{H \times (H \times S)}{2} = H \times W_T + H^2(S) = A_L$$

Figure 14. Levee Volume Sample Calculations

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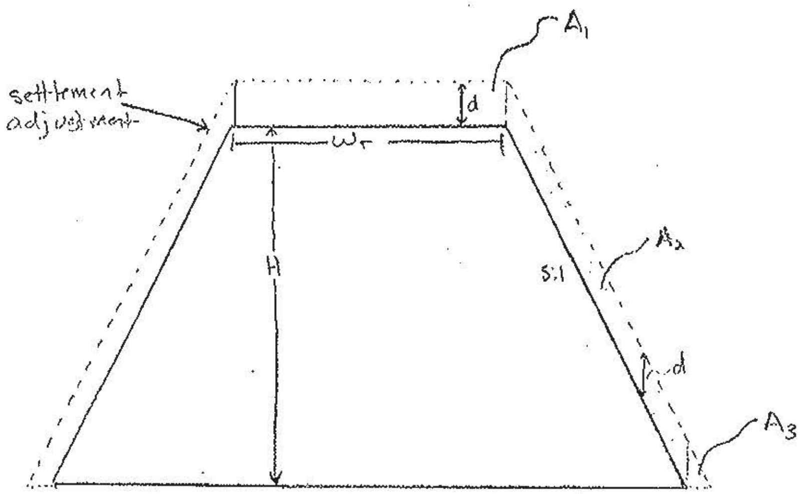
Project: Shoreline - FRM		Computed:	Date:
Subject: Levee Settlement Adjustment		Checked:	Date:
Task:		Page:	of:
Job #:		No:	



$A_1 = d \times W_T$

$A_2 = d\sqrt{H^2 + (H \times S)^2}$

$A_3 = \dfrac{d \times (d \times S)}{2} = \dfrac{d^2 S}{2}$

Total Settlement Adjustment $= A_1 + 2A_2 + 2A_3 = A_S$

Total Volume to add to adjust for settlement $= A_S \times$ Length

Figure 15. Levee Settlement Sample Calculations

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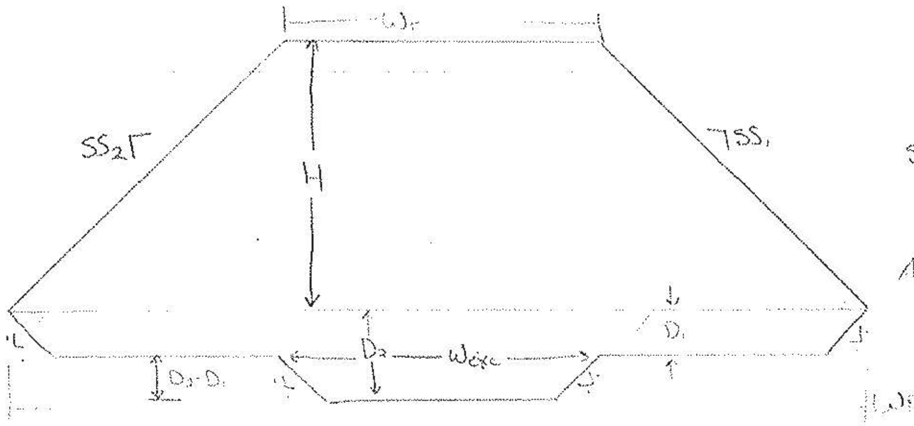
Project: Shoreline		Computed:	Date:
Subject: Levee Foundation Excavation		Checked:	Date:
Task:		Page:	of:
Job #:		No:	



$SS_1 = 3:1$

A_{exc}

$$A_{exc} = \left[\frac{W_{exc} + (W_{exc} - 2(D_2 - D_1))}{2}\right](D_2 - D_1) + \left[\frac{W_B + (W_B - 2D_1)}{2}\right] D_1$$

$$A_{exc} = (W_{exc} - D_2 + D_1)(D_2 - D_1) + (W_B - D_1)D_1$$

D_1 assumed = 2'
D_2 assumed = 4'

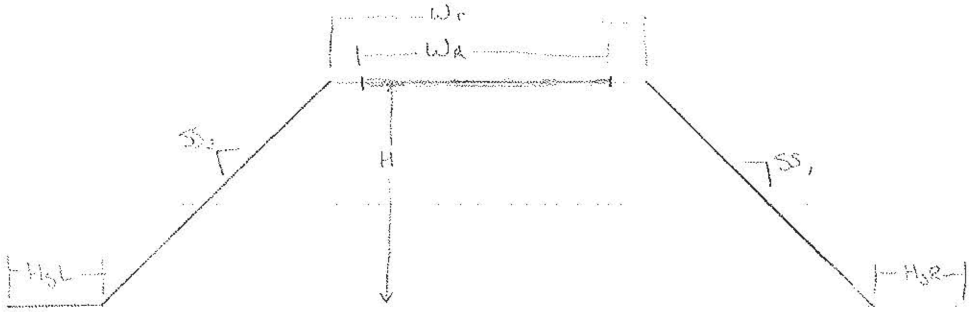
$$W_B = W_T + H(SS_1) + H(SS_2)$$

W_{exc} assumed equal to 18 feet.

Volume of Levee Foundation Excavation = A_{exc} x Length

Figure 16. Levee Foundation Excavation Sample Calculations

Project: Shoreline		Computed:	Date:
Subject: Hydroseeding		Checked:	Date:
Task:		Page:	of:
Job #:		No:	



Cross Sectional Width of Hydroseeding, W_{hy}

$$W_{hy} = \sqrt{H^2 + (S_2 H)^2} + \sqrt{H^2 + (S_1 H)^2} + H_sR + H_sL + W_r - W_R$$

Area of Hydroseeding = W_{hy} × Length

Assumed H_sR and H_sL = 5 feet
Paved Width, W_R = 16 feet where applicable

Note: W_R = 16' + W_r = 20' when a paved road is proposed. Otherwise, W_r = 16' & W_R = 0'

Figure 17. Hydroseeding Sample Calculations

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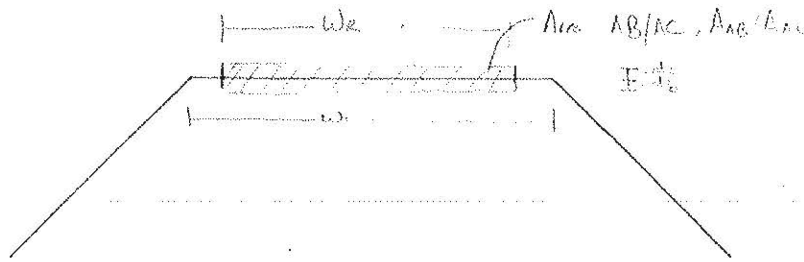
Project: Shoreline		Computed:	Date:
Subject: AB / AC		Checked:	Date:
Task:		Page:	of:
Job #:		No:	



$A_{AB} = W_R \times d_b$

Volume of $AB = A_{AB} \times$ Length

$A_{AC} = W_R \times d_c$

Volume of $AC = A_{AC} \times$ Length

Note: $W_R = 20'$ when a paved road is proposed.

Assumed $d_b = 6''$

$d_c = 2''$

$W_R = 16'$

Figure 18. Aggregate Base Asphault Concrete Sample Calculations

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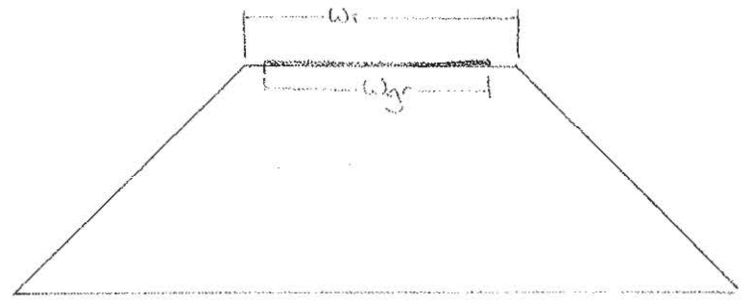
Project: Shoreline	Computed:	Date:	
Subject: Gravel	Checked:	Date:	
Task:	Page:	of:	
Job #:	No: -		



$A_{gr} = W_{gr} \times d_{gr}$

Assume $d_{gr} = .5'$

$W_{gr} = 12'$

Volume of gravel = $A_{gr} \times$ Length

Note: $W_r = 16'$ when a gravel roadway is proposed.

Figure 19. Gravel Sample Calculations

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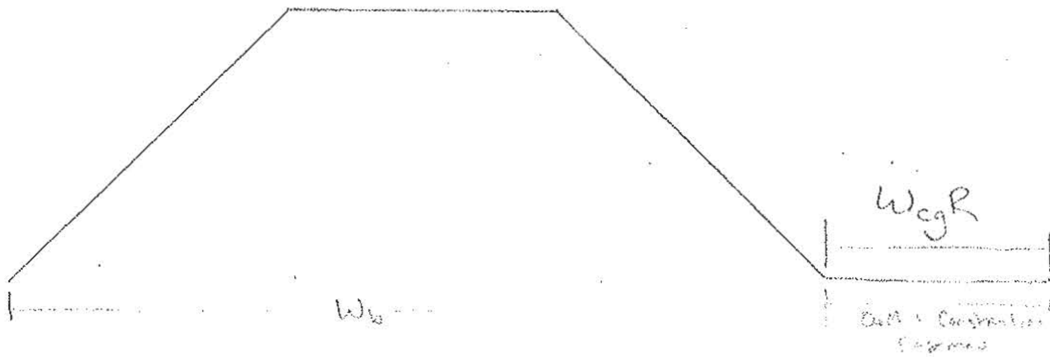
Project: Shoreline		Computed:	Date:
Subject: Clearing & Grubbing		Checked:	Date:
Task:		Page:	of:
Job #:		No:	



Clearing + Grubbing Width = $W_b + W_{cgR}$

Assume $W_{cgR} = 30'$

Area of C+G = $(W_b + W_{cgR}) \times$ Length

Figure 20. Clearing and Grubbing Sample Calculations

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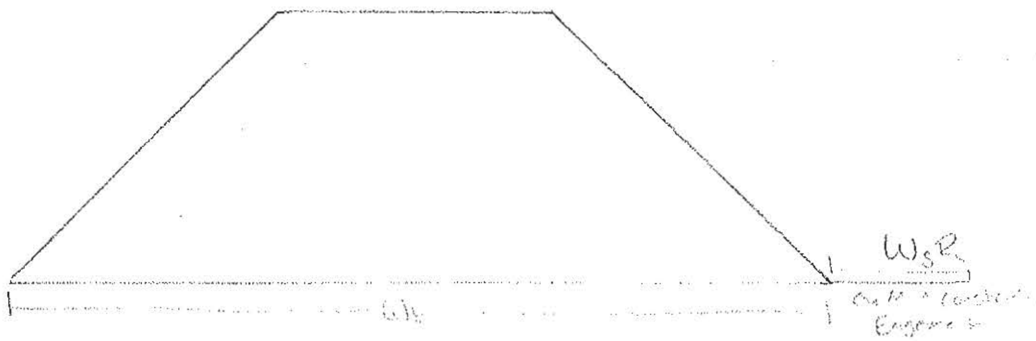
Project: Shoreline	Computed:	Date:
Subject: Stripping	Checked:	Date:
Task:	Page:	of:
Job #:	No:	



Assume $W_{SR} = 30'$

Assume depth of Stripping $d_s = 1'$

Width of Stripping $W_S = W_b + W_{SR}$

Cross Sectional Area of Stripping, $A_S = W_S \times d_S$

Volume of Stripping = Length × A_S

Figure 21. Stripping Sample Calculations

Project: Shoreline	Computed:	Date:	
Subject: Wick Drains	Checked:	Date:	
Task:	Page:	of:	
Job #:	No:		

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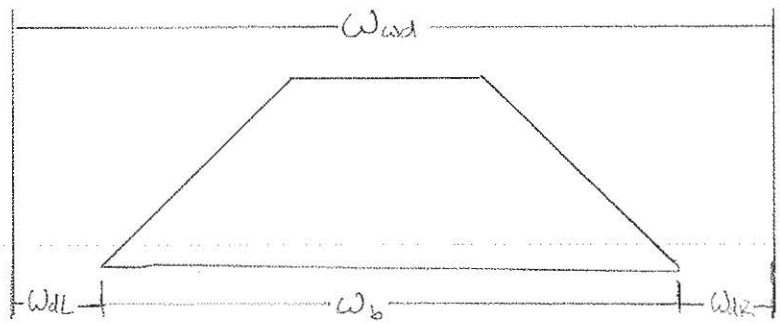
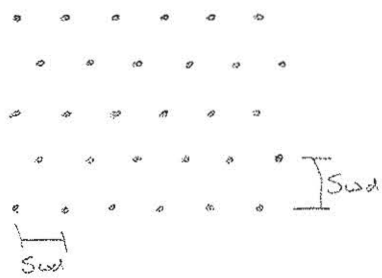


Wick Drain Configuration: Plan View



Width of Wick Drain Spacing, W_{wd}

$W_{wd} = W_b + W_{dR} + W_{dL}$

Length of Wick Drain Placement, L_{wd}

L_{wd} = Segment Length + 5' + 5'

Area Wick Drains Placement, A_{wd}

$A_{wd} = W_{wd} \times L_{wd}$

Total Wick Drains, T_{wd}

$T_{wd} = A_{wd} / S_{wd}^2$

Total Linear Footage of Wick Drains

$= T_{wd} \times$ (Bay Mud Depth + 5')

CMP Pipes:

Total number of Pipes, $T_c = L_{wd} / S_{wd}$

Total Length of Pipes, $L_c = T_c(W_{wd} + 1' + 1')$

Figure 22. Wick Drains Sample Calculations

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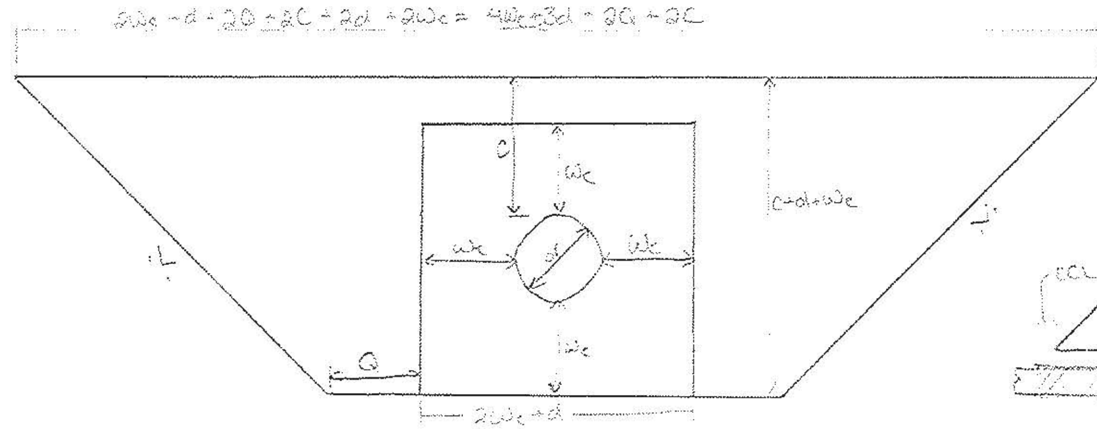
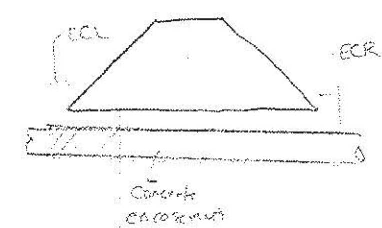
Project: Shoreline		Computed:	Date:
Subject: Concrete Encase Utility in Place.		Checked:	Date:
Task:		Page:	of:
Job #:		No:	





Excavation Cross Section Area, $A_{exc} = \left[\frac{(2w_e + d + 2Q) + (4w_e + 3d + 2Q + 2C)}{2}\right](c+d+w_e)$

$= \left(\frac{6w_e + 4d + 4Q + 2C}{2}\right)(c+d+w_e)$

assumed: $w_e = 2'$
$C = 3'$
$Q = 2'$

Length of Utility, L_{UT} = Levee Width + ECL + ECR ECL, ECR assumed = 5'

Volume of Excavation, $V_{exc} = A_{exc} \times L_{UT}$

Cross Section Area of Concrete Encasement, $A_{ec} = (2w_e + d)^2 - \pi\left(\frac{d}{2}\right)^2$

Volume of Concrete Encasement, $V_{ec} = A_{ec} \times L_{UT}$

Cross Section Area of Backfill, $A_{BF} = A_{exc} - \pi\left(\frac{d}{2}\right)^2 - A_{ec}$

Volume of Backfill, $V_{BF} = A_{BF} \times L_{UT}$

Figure 23. Utilities Relocation Sample Calculations

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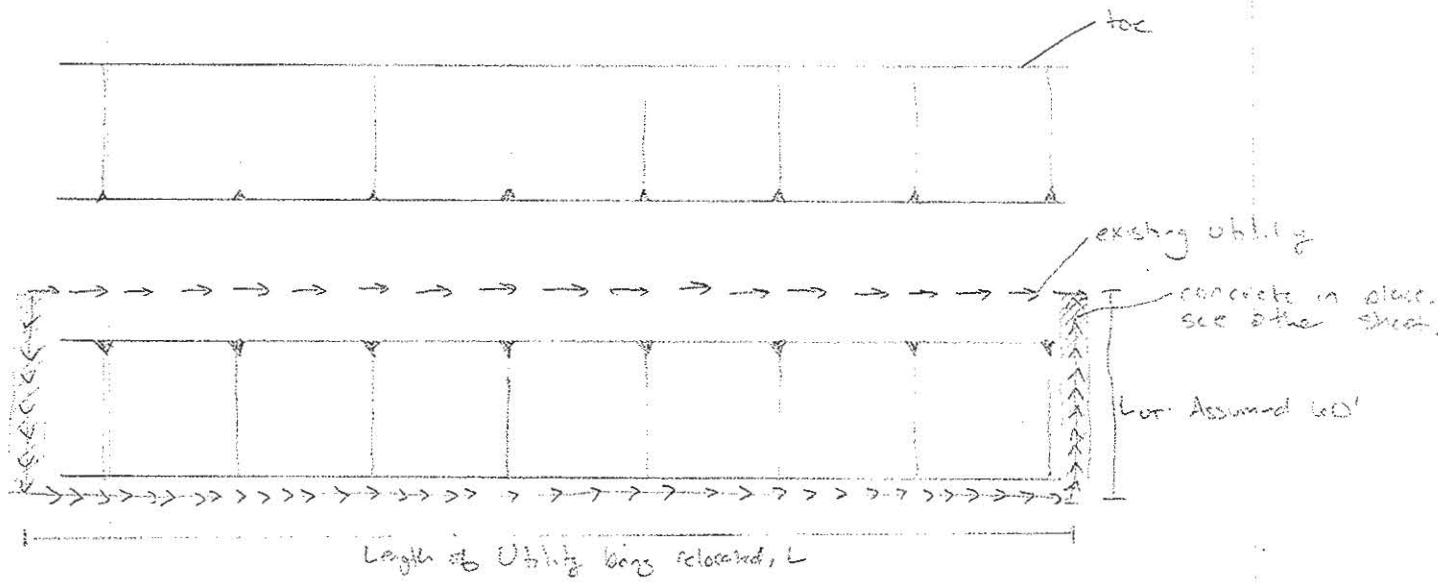
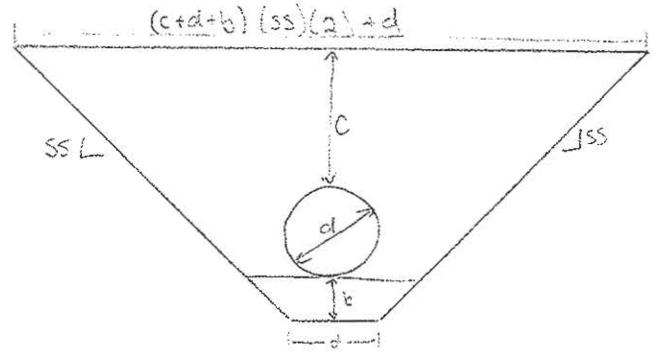
Project: Shoreline		Computed:	Date:
Subject: Relocate Utilities Underground		Checked:	Date:
Task:		Page:	of:
Job #:		No:	





XS Area of excavation, $A_{exc} = \left[\frac{((c+d+b)(ss)(2)+d)+d}{2}\right](c+d+b)$

Volume of excavation = $A_{exc} \times L$

XS Area of Bedding, $A_{Bed} = \left[\frac{[d+(b)(ss)(2)]+d}{2}\right]b$

Volume of Bedding, = $A_{Bed} \times L$

XS Area of Backfill, $A_{BF} = A_{exc} - A_{Bed} - \pi\left(\frac{d}{2}\right)^2$

Volume of Backfill = $A_{BF} \times L$

Figure 24. Utilities Relocation Sample Calculations

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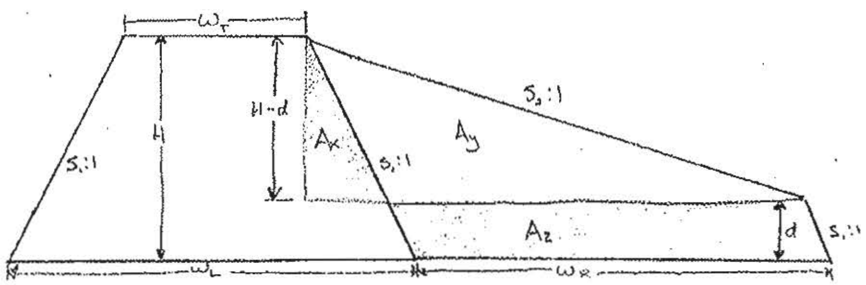
Project: Shoreline - Ecotones		Computed:	Date:
Subject: Restoration Volume 100:1 + 30:1		Checked:	Date:
Task:		Page:	of:
Job #:		No:	



$$W_R = (H-d)(S_2) - (H-d)(S_1)$$

$$A_x = \frac{(H-d)(H-d)(S_1)}{2} = \frac{(H-d)^2 S_1}{2}$$

$$A_y = \frac{(H-d)^2(S_2)}{2} - A_x$$

$$A_z = d W_R$$

Total Restoration Area $= A_y + A_z = A_R$

$$A_R = \frac{(H-d)^2(S_2)}{2} - A_x + d W_R$$

$$A_R = \frac{h^2 S_2}{2} - \frac{d^2 S_2}{2} - \frac{h^2 S_1}{2} + \frac{d^2 S_1}{2}$$

Figure 25. Ecotone Volume Sample Calculations

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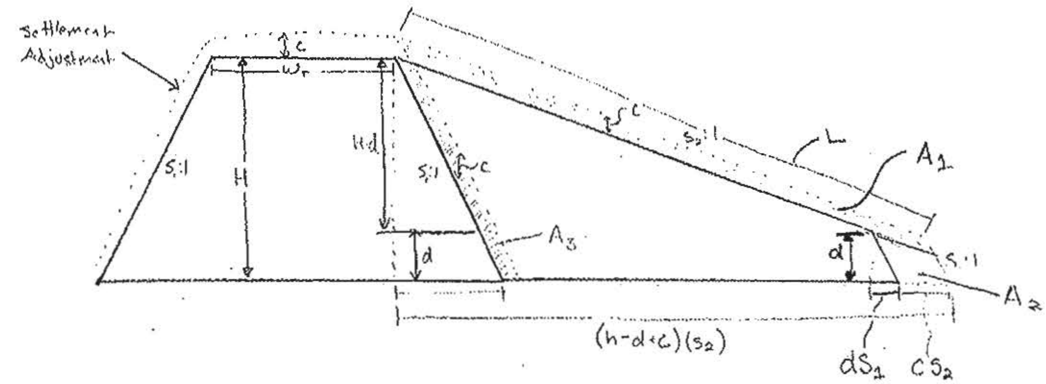
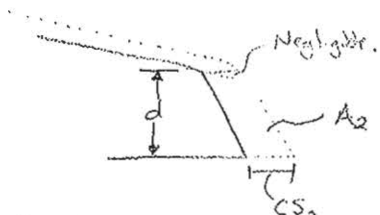
Project: Shoreline – Ecotones		Computed:	Date:
Subject: Restoration Settlement Adjustment		Checked:	Date:
Task:		Page:	of:
Job #:		No:	

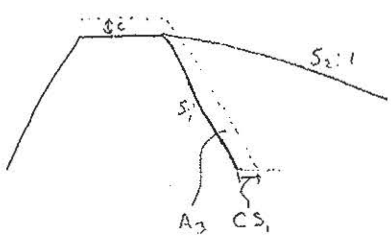


$$L = \sqrt{(h-d+c)^2 - [(h-d+c)S_2]^2}$$

$$A_1 = L \times C$$



$$A_2 = CS_2 d$$



$$A_3 = CS_1 \sqrt{H^2 + (CS_1)^2}$$

Cross Sectional Area of Restoration Settlement: $A_1 + A_2 - A_3 = A_T$

Total Volume to add to adjust for Settlement = A_T x Length

Figure 26. Ecotone Settlement Sample Calculations

Project: Shoreline - Ecotones		Computed:	Date:
Subject: Ecotone Hydroseeding		Checked:	Date:
Task:		Page:	of:
Job #:		No:	

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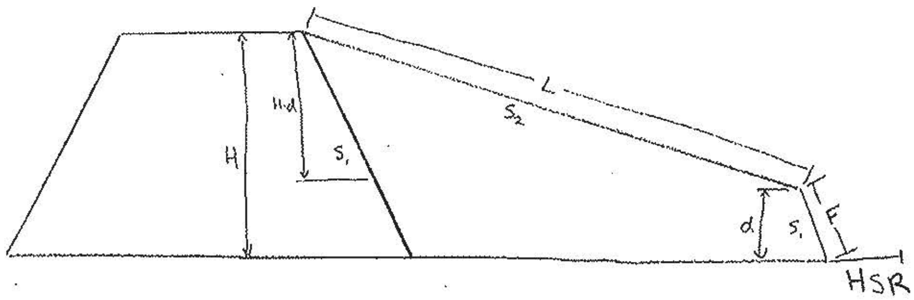

$$L = \sqrt{(H-d)^2 + [(H-d)(S_2)]^2}$$

$$F = \sqrt{d^2 + (dS_1)^2}$$

Total Cross Sectional Width of Hydroseeding = HSR + L + F = W_S

Area of hydroseeding = W_S × Length

Figure 27. Ecotone Hydroseeding Sample Calculations

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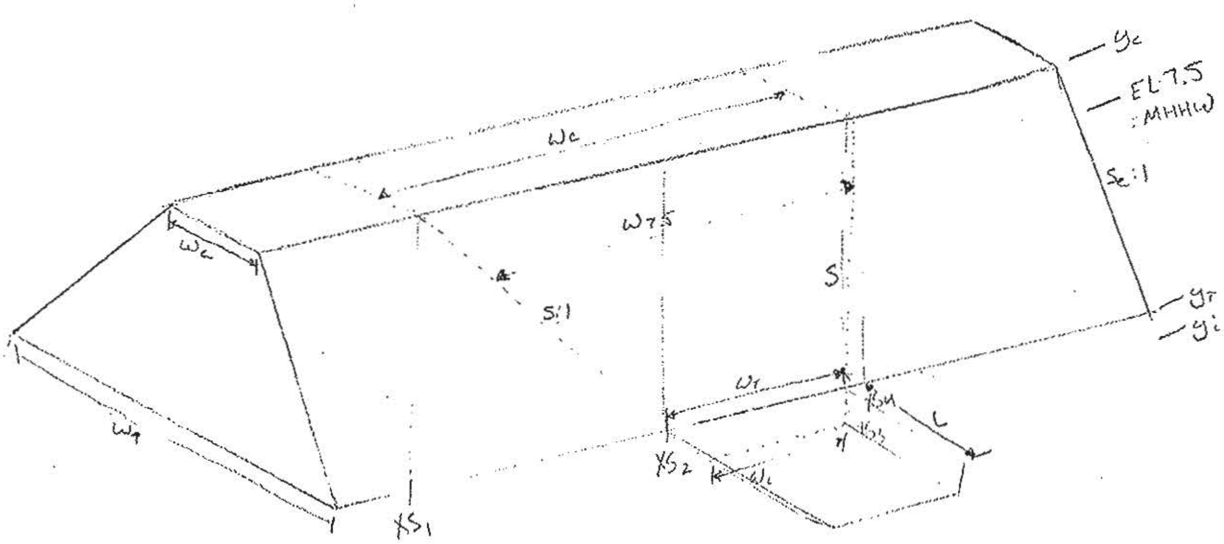
Project: Shoreline - Pond Restoration		Computed:	Date:
Subject: Internal Berm Breaches /		Checked:	Date:
Task: Outboard Levee Breaches		Page:	of:
Job #:		No:	



$$W_i = W_{7.5} - (MHHW - y_i)(S)(2)$$

$$W_c = W_i + (y_c - y_i)(S)(2)$$

Average End Method:

$$XS1 = XS4 = 0$$

$$XS2 = XS3 = W_c(y_c - y_T) + (y_c - y_T)^2(S_c)$$

Volume of Levee Excavation, X_L

$$X_L = \frac{(XS1 + XS2)}{2} \times \frac{(W_c - W_i)}{2} + \frac{(XS2 + XS3)}{2} \times (W_i) + \frac{(XS3 + XS4)}{2} \times \left(\frac{W_c - W_i}{2}\right)$$

Cross Sectional Area of extension, A_c

$$A_c = (W_i)(y_T - y_i) + (y_T - y_i)^2(S)$$

$$\text{Volume} = A_c \times L$$

Figure 28. Levee Breaches Sample Calculations

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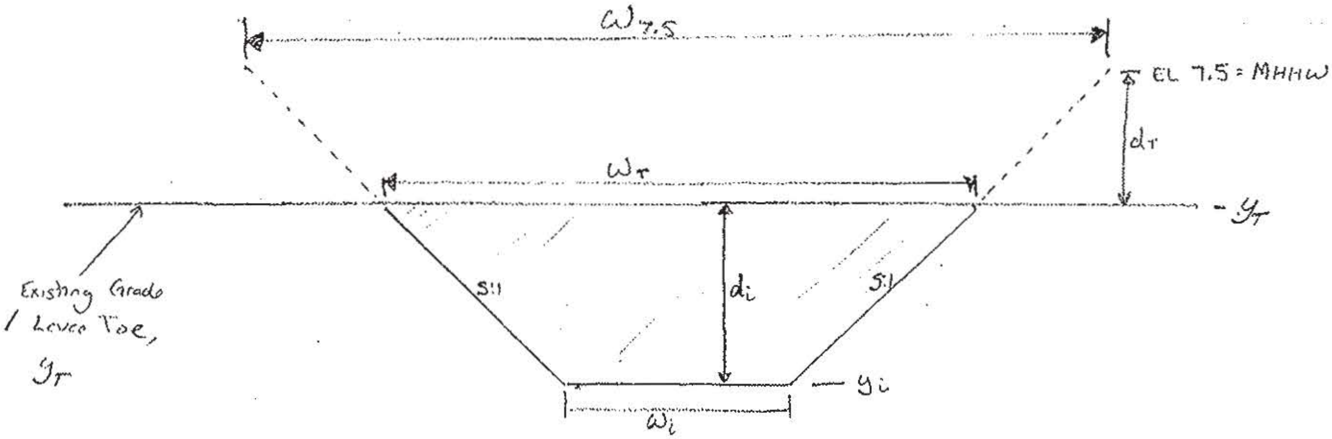
Project: Shoreline - Pond Restoration	Computed:	Date:
Subject: Pilot Channels	Checked:	Date:
Task:	Page:	of:
Job #:	No:	



$$\omega_i = (\omega_{7.5}) - (MHHW - y_i)(S) - (MHHW - y_i)(S)$$

$$A_{7.5} = (MHHW - y_i)(\omega_i) + (MHHW - y_i)^2(S)$$

$$A_T = (y_T - y_i)(\omega_i) + (MHHW - y_i)^2(S)$$

Excavation Volume = $A_T \times$ Length

Figure 29. Pilot Channels Sample Calculations

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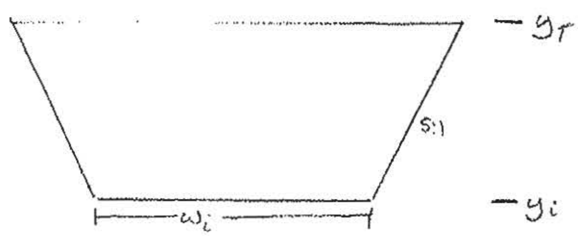
Project: Shoreline · Pond Restoration	Computed:	Date:	
Subject: Ditch Blocks	Checked:	Date:	
Task:	Page:	of:	
Job #:	No:		



$$\text{Area} = w_i (y_T - y_i) + (y_T - y_i)^2 (S)$$

$$\text{Volume} = \text{Area} \times \text{Length}$$

Figure 30. Ditch Blocks Sample Calculations

Project: Shoreline - Pond Restoration		Computed:	Date:
Subject: Internal Berm Interim Raising		Checked:	Date:
Task:		Page:	of:
Job #:		No:	

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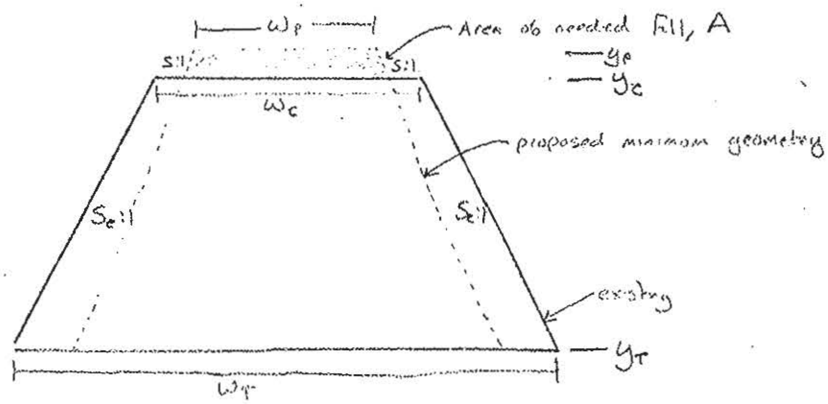
estimated Cross Section Geometry:



For area where proposed top width < existing top width

Excavation Volume (Lever reshaping volume)/

$$A = w_p(y_p - y_c) + (y_p - y_c)^2(s)$$

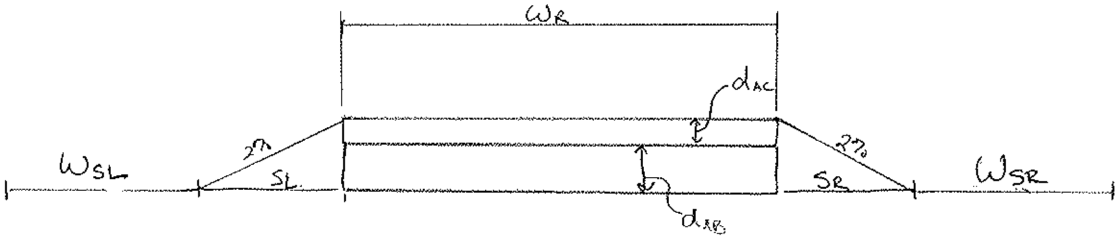
Volume = A x length

For area where proposed top width > existing top width: An AutoCAD model was used for estimating

Figure 31. Internal Berm Interim Raising Sample Calculations

Project: Shoreline - Recreation | Computed: | Date:
Subject: Bay Trails | Checked: | Date:
Task: | Page: | of:
Job #: | No: Figure 41

NTS



Area Asphalt Concrete = $d_{AC} \times W_R = A_{AC}$

Volume AC = $A_{AC} \times$ Length

Area Ag. Base = $d_{AB} \times W_R = A_{AB}$

Volume AB = $A_{AB} \times$ Length

Stripping depth = d_s

Stripping Volume = $(S_L + W_R + S_R) \times d_s \times$ Length

Area C+G = $(W_{SL} + S_L + W_R + S_R + W_{SR}) \times$ Length

Figure 32. Bay Trails Recreation Mitigation Sample Calculations

Quantity Tables

South San Francisco Bay Shoreline Study - Quantities

NED - Alviso North, WPCP South, 25-YR

Levee Work Quantities

Reach	From (ft.)	To (ft.)	Total Length (ft.)	Area Projection/Planar Area (SF)[1]	Average Width of Footprint (ft.)	Average Width of Levee Prism (ft.)	Excavation of Existing Levee (CY)[2]	Foundation Excavation (CY)	Fill Needed for Levee Embankment (CY)	Embankment and Foundation Fill Needed (CY)[3]	Useable Cut (50%) (CY)
Alviso North, WPCP South											
Sec 1	0+00	43+80	4,380.0	506,079.0	115.5	115.5	62,409.0	40,731.8	171,782.0	212,513.8	51,570.4
Sec 2	43+80	65+00	2,120.0	248,266.1	117.1	117.1	35,614.0	19,960.5	86,161.0	106,121.5	27,787.2
Sec 3	65+00	94+75	2,975.0	375,313.3	126.2	126.2	53,952.0	30,004.7	151,911.0	181,915.7	41,978.3
Sec 4	94+75	150+00	5,525.0	712,137.1	128.9	128.9	148,463.0	56,843.5	293,959.0	350,802.5	102,653.2
Sec 5	150+00	197+75	4,775.2	520,136.5	108.9	108.9	156,159.0	42,065.8	205,266.0	247,331.8	99,112.4
Total			**19,775.2**	**2,361,932.0**			**456,597.0**	**189,606.2**	**909,079.0**	**1,098,685.2**	**323,101.6**

Reach	Reusable Fill for Ecotone (50%) (CY)	Aggregate Base (CY)	Asphalt Concrete (CY)	Gravel (CY)	Required Borrow (CY)	Bank Run (CY)	Waste (CY)	Stripping (CY)	Hydroseed Proposed Levee (SY)	Hydroseed Proposed Levee (Acre)	Clearing and Grubbing (Acre)	Amount of Wick Drains (if Needed) (#)	Total Length of Wick Drains (lf)
Alviso North, WPCP South													
Sec 1	51,570.4	0.0	0.0	973.3	160,943.4	201,179.2	75,180.7	23,610.3	57,878.1	12.0	14.6	--	--
Sec 2	27,787.2	0.0	0.0	471.1	78,334.2	97,917.8	39,337.8	11,550.6	28,402.3	5.9	7.2	--	--
Sec 3	41,978.3	0.0	0.0	661.1	139,937.3	174,921.7	59,184.4	17,206.0	43,010.0	8.9	10.7	23,525.0	399,925.0
Sec 4	102,653.2	0.0	0.0	1,227.8	248,149.2	310,186.6	135,167.6	32,514.3	81,647.4	16.9	20.2	44,486.0	800,748.0
Sec 5	99,112.4	0.0	0.0	1,061.2	148,219.4	185,274.2	123,682.5	24,570.1	59,398.8	12.3	15.2	--	--
Total	**323,101.6**	**0.0**	**0.0**	**4,394.5**	**775,583.6**	**969,479.5**	**432,553.0**	**109,451.4**	**270,336.6**	**55.9**	**67.8**	**68,011.0**	**1,200,673.0**

[1]Value was exported from Civil3D

[2]Value was obtained using values from Civil3D and a representative levee cross section of the levee reach.

[3]Value was obtained using values from Civil3D and a representative excavation cross section of the levee reach.

Alviso to Artesian:	Construct new levees from existing high ground to the west of Alviso along the existing dikes bordering ponds A12, A13, and A16. this alignment ties into the closure structure at Artesian Slough just north of the Don Edwards Center.
Artesian:	Construct new tide gate north of Don Edwards Center.
Artesian to Coyote:	Remove and reconstruct levees from tide gate along existing dikes bordering pond A18, tying into existing levees along Coyote Creek. Top of levee elevation =15.11 plus settlement.

Utilty Work Quantities - a) Relocate beyond proposed toe to overhead configuration

Reach	Table	Number	Type of Utility	Length of Utility (FT)	Diameter of Utility (FT)	Existing Utility Demo (FT)
Alviso North, WPCP South						
Sec 2	Table 1B	9	Electrical supply to A18 Weir	684.8	1.0	684.8

Slope Protection at existing RR Bridge over Coyote

Depth (ft)	Total Linear Length of Protection (ft)	Height (ft)	Volume of Rock (CF)	Tons
7.0	2,000.0	10.0	140,000.0	8,400

South San Francisco Bay Shoreline Study - Restoration Quantities

Alviso North WPCP South, 25-YR

Restoration Quantities

Reach	From (ft.)	To (ft.)	Total Length (ft.)	Area Projection/Planar Area (SF)[1]	Average Width of Footprint (ft.)	Fill Needed for Restoration (CY)[2]	Reusable Fill From Levee Excavation (50%) (CY)	Reusable Fill Balance (CY)	Required Borrow (CY)	Bank Run (CY)	Stripping (CY)	Hydroseed Proposed Fill (SY)	Hydroseed Proposed Fill (Acre)	Clearing and Grubbing (Acre)
Low Fill														
Sec 1	0+00	43+80	4,380.0	219,000.0	50.0	84,198.3	51,570.4	96,401.1	-12,202.8	0.0	0.0	40,617.4	8.4	8.0
Sec 2	43+80	65+00	2,120.0	0.0	0.0	0.0	27,787.2	--	--	--	0.0	0.0	0.0	0.0
Sec 3	65+00	94+75	2,975.0	0.0	0.0	0.0	41,978.3	--	--	--	0.0	0.0	0.0	0.0
Sec 4	94+75	150+00	5,525.0	276,250.0	50.0	115,045.3	102,653.2	121,601.8	-6,556.5	0.0	0.0	51,235.5	10.6	10.1
Sec 5	150+00	197+75	4,775.2	238,759.0	50.0	90,133.6	99,112.4	105,098.7	-14,965.1	0.0	0.0	44,282.1	9.1	8.8
Total			**14,680.2**	**734,009.0**		**289,377.2**	**323,101.6**	**323,101.6**	**-33,724.4**	**0.0**	**0.0**	**136,135.0**	**28.1**	**27.0**

[1]Value was calculated on heights exported from Civil3D

[2]Value was obtained using values from Civil3D and a representative levee cross section of the levee reach.

Note: No imported borrow fill is necessary for construction of the bench due to the excess cut from the levee construction.

South San Francisco Bay Shoreline Study - Quantities

LPP - Alviso North, WPCP South, 100-YR

Levee Work Quantities

Reach	From (ft.)	To (ft.)	Total Length (ft.)	Area Projection/Planar Area (SF)[1]	Average Width of Footprint (ft.)	Average Width of Levee Prism (ft.)	Excavation of Existing Levee (CY)[2]	Foundation Excavation (CY)	Fill Needed for Levee Embankment (CY)	Embankment and Foundation Fill Needed (CY)[3]	Useable Cut (50%) (CY)	Reusable Fill for Ecotone (50%) (CY)	Aggregate Base (CY)	Asphalt Concrete (CY)	Gravel (CY)	Required Borrow (CY)	Bank Run (CY)	Stripping (CY)	Hydroseed Proposed Levee (Acre)	Clearing and Grubbing (Acre)	Amount of Wick Drains (if Needed) (#)	Total Length of Wick Drains (lf)
Alviso North, WPCP South																						
Sec 1	0+00	43+80	4,380.0	530,523.0	121.1	121.1	62,409.0	42,542.4	192,858.0	235,400.4	52,475.7	52,475.7	0.0	0.0	973.3	182,924.7	228,655.9	24,515.7	12.5	15.2	--	--
Sec 2	43+80	65+00	2,120.0	260,165.0	122.7	122.7	35,614.0	20,841.9	96,987.0	117,828.9	28,227.9	28,227.9	0.0	0.0	471.1	89,600.9	112,001.2	11,991.3	6.2	7.4	--	--
Sec 3	65+00	94+75	2,975.0	398,705.0	134.0	134.0	53,953.0	31,737.4	168,339.0	200,076.4	42,845.2	42,845.2	0.0	0.0	661.1	157,231.2	196,539.0	18,072.4	9.5	11.2	26,766.0	455,022.0
Sec 4	94+75	150+00	5,525.0	744,299.0	134.7	134.7	148,463.0	59,225.9	315,583.0	374,808.9	103,844.4	103,844.4	0.0	0.0	1,227.8	270,964.4	338,705.5	33,705.5	17.6	20.9	50,018.0	900,324.0
Sec 5	150+00	197+75	4,775.2	546,145.2	114.4	114.4	156,159.0	43,992.4	217,289.0	261,281.4	100,075.7	100,075.7	0.0	0.0	1,061.2	161,205.7	201,507.1	25,533.4	12.9	15.8	--	--
Total			**19,775.2**	**2,479,837.2**			**456,598.0**	**198,339.9**	**991,056.0**	**1,189,395.9**	**327,469.0**	**327,469.0**	**0.0**	**0.0**	**4,394.5**	**861,927.0**	**1,077,408.7**	**113,818.2**	**58.7**	**70.5**	**76,784.0**	**1,355,346.0**

[1]Value was exported from Civil3D

[2]Value was obtained using values from Civil3D and a representative levee cross section of the levee reach.

[3]Value was obtained using values from Civil3D and a representative excavation cross section of the levee reach.

Alviso to Artesian:	Construct new levees from existing high ground to the west of Alviso along the existing dikes bording ponds A12, A13 and A16. This alignment ties into the closure structure at Artesian Slough just north of the Don Edwards Center.
Artesian:	Construct new tide gate north of Don Edwards Center.
Artesian to Coyote:	Remove and reconstruct levees from tide gate along existing dikes bordering pond A18, tying into exisiting levees along Coyote Creek. Top of levee elevation =16 plus settlement.

Utilty Work Quantities - a) Relocate beyond proposed toe to overhead configuration

Reach	Table	Number	Type of Utility	Length of Utility (FT)	Diameter of Utility (FT)	Existing Utility Demo (FT)
Alviso North, WPCP South						
Sec 2	Table 1B	9	Electrical supply to A18 Weir	684.8	1.0	684.8

Slope Protection at existing RR Bridge over Coyote

Depth (ft)	Total Linear Length of Protection (ft)	Height (ft)	Volume of Rock (CF)	Tons
7.0	2,000.0	10.0	140,000.0	8,400

South San Francisco Bay Shoreline Study - Restoration Quantities

Alviso North WPCP South, 100-YR
Restoration Quantities, 30:1

Reach	From (ft.)	To (ft.)	Total Length (ft.)	Area Projection/Planar Area (SF)[1]	Average Width of Footprint (ft.)	Fill Needed for Restoration (CY)[2]	Total Reusable Fill From Levee Excavation (50%) (CY)	Reusable Fill Balance (CY)	Available Onsite Fill (CY)	Required Borrow (CY)	Bank Run (CY)	Stripping (CY)	Hydroseed Proposed Fill (SY)	Hydroseed Proposed Fill (Acre)	Clearing and Grubbing (Acre)
Low Fill															
Sec 1	0+00	43+80	4,380.0	1,300,860.0	297.0	704,439.9	52,475.7	97,704.1	606,735.8	0.0	0.0	0.0	170,817.4	35.3	32.9
Sec 2	43+80	65+00	2,120.0	0.0	0.0	0.0	28,227.9	--	--	--	--	--	--	--	--
Sec 3	65+00	94+75	2,975.0	0.0	0.0	0.0	42,845.2	--	--	--	--	--	--	--	--
Sec 4	94+75	150+00	5,525.0	1,640,925.0	297.0	1,037,448.4	103,844.4	123,245.5	914,202.9	0.0	0.0	0.0	215,471.7	44.5	41.5
Sec 5	150+00	197+75	4,775.2	1,418,228.5	297.0	420,185.6	100,075.7	106,519.4	313,666.2	0.0	0.0	0.0	186,229.2	38.5	35.8
Total			**14,680.2**	**4,360,013.5**		**2,162,073.9**	**327,469.0**	**327,469.0**	**1,834,604.9**	**0.0**	**0.0**	**0.0**	**572,518.3**	**118.3**	**110.2**
					Assume Onsite Fill Available:		1,834,605								

[1]Value was calculated on heights exported from Civil3D
[2]Value was obtained using values from Civil3D and a representative levee cross section of the levee reach.

South San Francisco Bay Shoreline Study - Quantities

LPP - 100 year (1%) Level of Protection

Pond Restoration Quantities - Outboard Levee Breaches

Watershed	Existing Top Elevation (ft.)	Levee Toe Elevation (ft.)	Existing Levee Side Slopes (H:V)	Existing Levee Top Width (ft.)	Existing Levee Bottom Width (ft.)	Breach top Width @ Existing Top Elevation	Breach Invert Elevation (ft.)	Breach Top Width @ EL 7.5	Breach XS Area @ EL 7.5	Breach Bottom Width (ft.)	Breach Slopes (H:V)	Excavation Volume Breach of Levee Only (CY)	Cross Sectional Area of Breach Extension (SF)	Total Extension Length (ft.)	Excavation Volume (CY)
Pond A12 (1) (A11 in memo)	12.0	-2.0	5.8	10.0	172.0	186.7	-6.3	145.0	865.0	17.2	4.6	129,867.7	159.6	100.0	5,400.9
Pond A12 (2)	12.0	8.0	18.4	24.0	171.0	191.5	-6.5	150.0	910.0	21.0	4.6	41,430.5	1,273.2	100.0	6,249.8
Phase 1 Total:	--	--	--	--	--	--	--	--	--	--	--	**171,298.2**	--	**200.0**	**11,650.8**
Pond A9*	12.0	0.0	3.8	10.0	100.0	232.4	-8.6	190.0	1,300.0	38.4	4.7	89,355.0	678.4	100.0	5,822.2
West Pond A9*	12.0	0.0	3.8	10.0	100.0	232.4	-8.6	190.0	1,300.0	38.4	4.7	89,355.0	678.4	100.0	5,822.2
Pond A10*	12.0	0.0	3.8	10.0	100.0	180.3	-6.0	140.0	820.0	19.0	4.5	65,780.0	275.3	100.0	3,456.0
Pond A10West*	12.0	0.0	3.8	10.0	100.0	180.3	-6.0	140.0	820.0	19.0	4.5	65,780.0	275.3	100.0	3,456.0
North A18	14.0	1.0	5.0	7.0	137.0	156.1	-3.9	100.0	520.0	1.6	4.3	73,806.1	111.5	100.0	3,146.4
Central A18	14.0	5.0	2.9	7.7	60.0	193.4	-5.9	135.0	805.0	14.6	4.5	31,684.1	692.9	100.0	3,739.8
West A18	14.0	5.0	3.8	11.0	80.0	205.0	-6.4	145.0	890.0	16.6	4.6	45,381.4	789.5	100.0	4,604.8
East A18	16.0	9.0	5.4	30.0	106.0	223.5	-6.4	145.0	890.0	16.6	4.6	57,148.1	1,351.0	100.0	7,120.3
Southwest A18	14.0	5.0	3.8	11.0	80.0	205.0	-6.4	145.0	890.0	16.6	4.6	45,381.4	789.5	100.0	4,604.8
South A18	14.0	5.0	3.8	11.0	80.0	205.0	-6.4	145.0	890.0	16.6	4.6	45,381.4	789.5	100.0	4,604.8
Phase 2 Total:	--	--	--	--	--	--	--	--	--		--	**518,289.6**	--	**800.0**	**37,167.9**
Pond A13-15	12.0	2.0	8.6	23.0	195.0	305.8	-11.6	260.0	2,080.0	65.4	5.1	202,330.3	1,831.7	100.0	14,277.7
Phase 3 Total:	--	--	--	--	--	--	--	--	--	--	--	**202,330.3**	--	**100.0**	**14,277.7**

*Values for these ponds are assumed due to lack of topographical data

MHHW: 7.5

Note: **Phase 1** Construction: 2020 - 2021

Phase 2 Construction: 2025 - 2026

Phase 3 Construction: 2030 - 2031

South San Francisco Bay Shoreline Study - Quantities

LPP - 100 year (1%) Level of Protection

Pond Restoration Quantities - Internal Berm Breaches

Watershed	Number of Breaches	Existing Top Elevation (ft.)	Levee Toe Elevation (ft.)	Existing Levee Side Slopes (H:V)	Existing Levee Top Width (ft.)	Existing Levee Bottom Width (ft.)	Breach top Width @ Existing Top Elevation (ft.)	Breach Invert Elevation (ft.)	Breach Top Width @ EL 7.5 (ft.)	Breach XS Area @ EL 7.5 (SF)	Breach Bottom Width (ft.)	Breach Slopes (H:V)	Volume of Excavation of Breach of Levee Only (CY)	Cross Sectional Area of Breach Extension (SF)	Total Extension Length (ft.)	Volume of Breach Extension (CY)	Excavation Volume (CY)
Pond A9/A14*	2.0	10.0	0.0	4.0	15.0	80.0	80.0	-1.6	65.0	1,300.0	10.4	3.0	920.7	24.3	100.0	90.1	2,021.6
A12/A11*	1.0	10.0	0.0	4.0	15.0		125.0	-1.6	65.0	1,300.0	55.4	3.0	1,837.4	96.3	100.0	356.7	2,194.1
Phase 1 Total:	**3.0**	--	--	--	--	--	--	--	--	--	--	--	**2,758.1**	--	**200.0**	**446.8**	**4,215.8**
Pond A10/A11*	1.0	10.0	0.0	4.0	15.0	80.0	160.0	-5.6	140.0	820.0	35.2	4.0	1,988.1	322.6	100.0	1,194.7	3,182.8
Phase 2 Total:	**1.0**	--	--	--	--	--	--	--	--	--	--	--	**1,988.1**	--	**100.0**	**0.0**	**3,182.8**
Pond A13-15	11.0	7.8	0.7	4.4	20.0	82.2	77.0	-2.1	75.0	865.0	17.4	3.0	635.4	73.0	100.0	270.4	9,963.3
Phase 3 Total:	**11.0**	--	--	--	--	--	--	--	--	--	--	--	**635.4**	--	**100.0**	**270.4**	**9,963.3**

*Values for these ponds are assumed due to lack of topographical data

MHHW: 7.5

Note: **Phase 1** Construction: 2020 - 2021

Phase 2 Construction: 2025 - 2026

Phase 3 Construction: 2030 - 2031

Quantities 06 - Quantities for Pond Restoration Internal Berm Breaches

South San Francisco Bay Shoreline Study - Quantities

LPP - 100 year (1%) Level of Protection

Pond Restoration Quantities - Pilot Channels

Watershed	Levee Toe Elevation (ft.)	Pilot Channel Invert Elevation (ft.)	Pilot Channel Top Width @ EL 7.5 (ft.)	Pilot Channel Slopes (H:V)	Pilot Channel Bottom Width (ft.)	Pilot Channel XS Area @ EL 7.5	Pilot Channel XS Area @ Grade (SF)	Length of Pilot Channel (ft.)	Exavation Volume (CY)
Pond A12 (1) (A11 in memo)	0.0	-6.3	100.0	3.0	17.2	808.7	227.4	155.0	1,305.6
Pond A12	8.0	-6.5	105.0	3.0	21.0	882.0	431.3	575.0	9,184.0
Phase 1 Total:	--	--	--	--	--	--	--	**730.0**	**10,489.6**
Pond A9*	0.0	-8.6	135.0	3.0	38.4	1,395.9	552.1	1,480.0	30,264.4
West Pond A9*	0.0	-8.6	135.0	3.0	38.4	1,395.9	552.1	1,480.0	30,264.4
Pond A10*	0.0	-6.0	100.0	3.0	19.0	803.3	222.0	265.0	2,178.9
Pond A10West*	0.0	-6.0	100.0	3.0	19.0	803.3	222.0	300.0	2,466.7
North A18	1.0	-3.9	70.0	3.0	1.6	408.1	53.5	130.0	257.4
Central A18	5.0	-5.9	95.0	3.0	14.6	734.3	263.6	175.0	1,708.3
West A18	5.0	-6.4	100.0	3.0	16.6	810.4	312.1	330.0	3,814.8
East A18	9.0	-6.4	100.0	3.0	16.6	810.4	378.5	490.0	6,869.4
Southwest A18	5.0	-6.4	100.0	3.0	16.6	810.4	312.1	0.0	0.0
Phase 2 Total:	--	--	--	--	--	--	--	**4,650.0**	**77,824.3**
Pond A13-15	-2.0	-11.6	180.0	3.0	65.4	2,343.6	1,031.5	1,110.0	42,406.9
Phase 3 Total:	--	--	--	--	--	--	--	**1,110.0**	**42,406.9**

*Values for these ponds are assumed due to lack of topographical data

MHHW: 7.5

Note: **Phase 1** Construction: 2020 - 2021

Phase 2 Construction: 2025 - 2026

Phase 3 Construction: 2030 - 2031

South San Francisco Bay Shoreline Study - Quantities

LPP - 100 year (1%) Level of Protection

Pond Restoration Quantities - Ditch Blocks

Pond	Number of Ditch Blocks	Top Elevation (ft.)	Toe Elevation (ft.)	Side Slopes (H:V)	Top Width (ft.)	XS Area (SF)	Approx. Avg Length (ft.)	Volume per Block (CY)	Required Fill (CY)	Bank Run (CY)
Pond A12 (1) (A11 in memo)	2.0	0.0	-6.3	5.0	50.0	513.5	20.0	380.3	760.7	950.8
Pond A12 (2)	2.0	8.0	-6.5	5.0	50.0	1,776.3	20.0	1,315.7	2,631.5	3,289.4
Phase 1 Total:	**4.0**	--	--	--	--	--	--	--	**3,392.1**	**4,240.2**
Pond A9	1.0	0.0	-8.6	5.0	50.0	799.8	20.0	592.4	592.4	740.6
Pond A10	2.0	0.0	-6.0	5.0	50.0	480.0	20.0	355.6	711.1	888.9
Pond A11	4.0	0.0	-5.6	5.0	50.0	436.8	20.0	323.6	1,294.2	1,617.8
Pond A18 North	1.0	1.0	-3.9	5.0	50.0	365.1	20.0	270.4	270.4	338.0
Pond A18 Central	1.0	5.0	-5.9	5.0	50.0	1,139.1	20.0	843.7	843.7	1,054.7
Pond A18 Southwest	1.0	5.0	-6.4	5.0	50.0	1,219.8	20.0	903.6	903.6	1,129.4
Pond A18 East	1.0	9.0	-6.4	5.0	50.0	1,955.8	20.0	1,448.7	1,448.7	1,810.9
Phase 2 Total:	**11.0**	--	--	--	--	--	--	--	**6,064.2**	**7,580.3**
Pond A13	2.0	0.7	-2.1	5.0	50.0	179.2	20.0	132.7	265.5	331.9
Pond A14	6.0	1.0	-3.1	5.0	50.0	289.1	20.0	214.1	1,284.7	1,605.8
Pond A15	3.0	-2.0	-11.6	5.0	50.0	940.8	20.0	696.9	2,090.7	2,613.3
Phase 3 Total:	**11.0**	--	--	--	--	--	--	--	**3,640.8**	**4,551.0**

*Values for these ponds are assumed due to lack of topographical data

Note: **Phase 1** Construction: 2020 - 2021

Phase 2 Construction: 2025 - 2026

Phase 3 Construction: 2030 - 2031

South San Francisco Bay Shoreline Study - Quantities

LPP - 100 year (1%) Level of Protection

Pond Restoration Quantities - Internal Berm Interim Raising

Pond	Length (ft.)	Existing Top Elevation (ft.)	Levee Toe Elevation (ft.)	Existing Levee Top Width (ft.)	Existing Levee Bottom Width (ft.)	Exisitng Levee Slopes (H:V)	Existing Levee XS Area (SF)	Proposed Top Elevation (ft.)	Proposed Top Width (ft.)	Proposed Slope (H:V)	Proposed XS Area (SF)	Existing Levee Volume (CY)	Proposed In-Place Volume (CY)	Required Borrow (CY)	Difference in Geometry Volume (CY)	Excavation Volume (CY)**
Pond A12 North & Northwest	4,590.0	8.5	0.0	10.0	90.0	4.7	425.0	9.8	12.5	2.5	362.6	72,250.0	61,642.0	0.0	10,608.0	5,045.6
Phase 1 Total:	**4,590.0**	--	--	--	--	--	--	--	--	--	--	**72,250.0**	**61,642.0**	--	**10,608.0**	**5,045.6**
Pond A9 East*	3,440.0	9.0	0.0	15.0	80.0	3.6	427.5	9.8	12.5	2.5	362.6	54,466.7	46,197.9	0.0	8,268.7	1,477.9
Pond A11 North and East*	4,900.0	9.0	0.0	15.0	80.0	3.6	427.5	9.8	12.5	2.5	362.6	77,583.3	65,805.2	0.0	11,778.1	2,105.2
Phase 2 Total:	**8,340.0**	--	--	--	--	--	--	--	--	--	--	**132,050.0**	**112,003.1**	**0.0**	**20,046.9**	**3,583.1**

*Values for these ponds are assumed due to lack of topographical data

**Existing berm geometry provides for a larger cross sectional area despite the shorter berm height. Exacation Volume is for reshaping of the existing berm.

Note: **Phase 1** Construction: 2020 - 2021

Phase 2 Construction: 2025 - 2026

Phase 3 Construction: 2030 - 2031

South San Francisco Bay Shoreline Study - Restoration Quantities

Bay Trails Recreation Mitigation

Length	Paved Width (ft)	Compacted Dirt Shoulder, Width (each side, ft)	Total Width (ft)	Aggregate Base (CY)	Asphault Concrete (CY)	Clearing and Grubbing (AC)	Stripping (CY)
12,200.0	10.0	3.0	16.0	2,259.3	903.7	10.1	7,229.6

South San Francisco Bay Shoreline Study - Restoration Quantities

Alviso North WPCP South, 100-YR

Pedestrian Bridges

Reach	Length (ft)	Excavation (Bridge) (CY)	Excavation (Type D) (CY)	Excavation (Retaining Wall) (CY)	Backfill (Bridge) (CY)	Backfill (Retaining Wall) (CY)	16" Steel Pipe Piling Total Length (ft)	# 16" Steel Pipe Piling	48" Cast-in-Steel-Shell Piling Total Length (ft)	# 48" Cast-inSteel-Shell Piling	Concrete (CY)	Box Truss Length (ft)	# of Box Truss	Bar Reinforcing Steel (bridge) (lb)	Ornamental Railing (ft)	Pedestrian Gateway Enhancements	Bird Exclusion Measures
Rail Road Crossing	380	80	29	116	44	203	917	10	262	4	291	127	3	28088	27	1	1
WPCP Discharge Crossing	100	21	8	31	12	54	252	4	70	4	75	100	1	7395	60	1	1

Note: These numbers are developed based on a 2006 report titled "Alviso Slough Pedestrian Bridge Feasibility Study, Bay Trail Reach 9B" prepared for the City of San Jose. Values are scaled/estimated based on overall bridge length and other factors unique to each project. These numbers are for cost estimating purposes only.